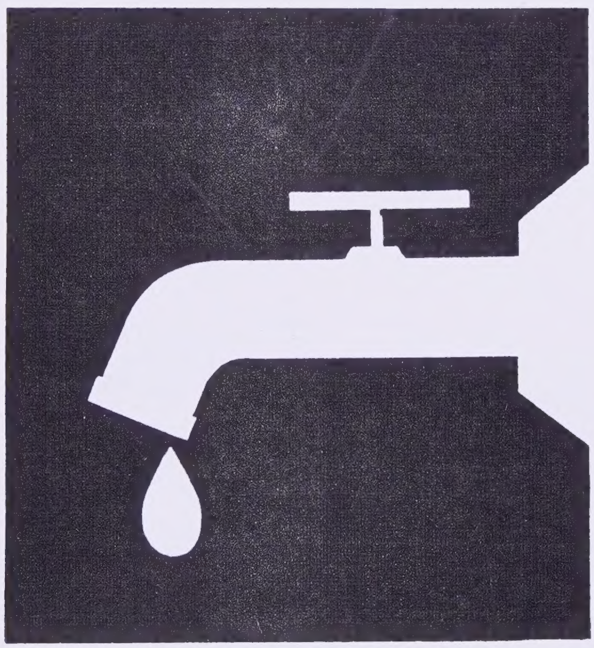
Report to the

CITY COUNCIL
OF THE
CITY OF SANTA MARIA



LONG-TERM WATER MANAGEMENT PLAN

Water Advisory Committee

FEBRUARY 1991

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Water Advisory Committee

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ACKNOWLEDGMENTS

The Advisory Committee would like to express its appreciation to members of the City staff who assisted in the preparation of this report. Tim Ness, Deputy City Administrator, provided invaluable assistance and helped keep us on track and on pace. Kerry Boyle, City Water Conservation Coordinator, provided the committee with important technical information and drafted the Water Conservation chapter. Sandy Boyd, Administrative Secretary, did an excellent job of organizing and typing the manuscript.

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I. EXECUTIVE SUMMARY

A. Introduction

On February 6, 1990, the Santa Maria City Council established a Water Management Advisory Committee. Each Council member appointed a person from the community to serve on the advisory committee. Mayor George Hobbs appointed Toru Miyoshi, who was then serving as Fifth District County Supervisor. Council Member Curtis Tunnell appointed Herb Gerfen, a civil engineer and co-chair of the Joint Water Committee of the Chamber of Commerce and Economic Development Association. Council Member Tom Urbanske appointed Charles Varni, sociology instructor at Allan Hancock College and member of the Santa Maria Earth Day Coalition. Council Member Bob Orach appointed Richard Quandt, President of the Grower-Shipper Vegetable Association and current Fifth District representative to the County Planning Commission. Council Member Dan Firth appointed Maurice Twitchell, private attorney and Secretary of the Santa Maria Valley Water Conservation District.

The charge of the committee was to prepare a long-term water management plan as well as to advise the City Council on matters concerning water resource management.

The City Council asked the committee to report on the following topics:

1. City contribution toward replenishing or "healing" the Santa Maria Valley groundwater basin;

2. Prevention of future degradation of the groundwater in the Santa Maria Valley, with particular emphasis on water softener salt disposal;

3. Management and use of supplemental water from the State Water Project, if obtained;

4. Review of present water conservation efforts, and recommendations on the development of new programs to improve water conservation, including landscape guidelines and water pricing structures;

5. Recommendations on establishing a cooperative effort with other water users in the Santa Maria Valley to develop a plan for the reduction or elimination of groundwater overdraft in the Santa Maria Valley;

6. Reconciliation of total water resources with the densities found in the Land Use Element of the General Plan.

The purpose of a Long-Term Water Management Plan is to help guide the Council in its decision-making process regarding water issues. This report will provide information and recommendations which the Council can refer to when making water policy decisions.

This report examines the Santa Maria groundwater basin and considers water supply, demand and quality. The committee has reviewed numerous studies, surveys, and reports and has utilized generally accepted conclusions throughout the report. This report also considers alternative sources of long-term water supplies.

B. Summary

The water supply of the City has historically been the Santa Maria Valley groundwater basin. It is estimated that the basin was full in 1918 and contained about three million acre feet of usable water in storage. The accelerated development of irrigated agriculture in the period following World War I and steady urban growth have resulted in the depletion of approximately two-thirds of the accumulated water stored in the basin. It is estimated that about one million acre feet of usable available water remain in storage. This water must supply the present needs of both agriculture and urban users as well as future needs if supplemental water is not obtained. It is clear that present groundwater resources cannot supply the present and future water needs of the Santa Maria Valley indefinitely.

At present, agriculture consumes 80 percent of the water used in the Santa Maria Valley. It is expected that agriculture's share of water use will remain constant or decline slightly in the future, while urban use will expand. At present, the consumptive use of urban and agricultural water (water used or applied, less excess water returned to the groundwater basin) is as follows:

Consumptive Use in Acre Feet for 1989

1.	Irrigated agriculture	85,544
2.	Livestock	1,000
3.	City of Santa Maria	8,356
4.	Calif. Cities Water Co.	6,593
5.	City of Guadalupe	892
6.	Holly Sugar	1,841
7.	Union Oil	2,000
	Total	106,226

The long-term average recharge of the basin is 76,200 acre feet per year (AFY). Therefore, there is an annual average overdraft of the Santa Maria groundwater basin of about 30,000 acre feet. At this rate of overdraft, the available water in the basin could be exhausted in less than 30 years. Continuation of dry years without recharge could shorten this time considerably.

Water quality in the basin has been declining for many years and is the most immediate problem for the City. At present, water from City wells at the airport contains more than 800 parts per million (ppm) total dissolved solids (TDS), including a weighted average of 463 ppm total hardness (TH). The maximum federal limit for municipal water TDS is 500 ppm, and the state limit is

1,000 ppm. The American Water Works Association recommended quality goal for total dissolved solids is less than 200 ppm.

While the overdraft of the basin is serious and a threat to agriculture and the basin economy, a more serious threat to urban users is the local pumping depression of the Orcutt sub-basin, which supplies water to the City of Santa Maria and the Orcutt area. The overdraft in the Orcutt sub-basin is at least four times as severe as that in the basin as a whole. Urban and agricultural pumpage of water from the sub-unit is about 28,240 acre feet per year while the safe yield is 9,670 acre feet, resulting in an annual gross overdraft of about 18,570 acre feet. This overdraft is more than 200 percent of the safe yield of the sub-basin compared to 40 percent for the basin as a whole.

This overdraft has resulted in a pumping depression in the Orcutt sub-basin of 60 to 80 feet. This depression draws poor quality water into the area of pumpage from adjacent areas, degrading the urban water. The overdraft also increases the threat of subsidence, which would permanently destroy or reduce the capacity of the sub-basin to store water. This source of urban water is thus threatened to a much greater extent than the basin as a whole.

Continued overdrafting will cause both the Orcutt sub-basin and the basin as a whole to become unreliable, both as to the quality of the water and as a reliable source of water. When this occurs, the City will either have to demineralize groundwater or obtain other high-quality water to solve the quality problem. As the available storage declines, the City will have to either obtain supplemental water or take water from agricultural users by condemnation or other means.

Most of the local sources of supplemental water, such as demineralizaton of oilfield brine or sea water, watershed management, a dam on the Sisquoc River and spreading grounds in the Santa Maria River Bed, are more costly than the State Water Project. All of the local sources, other than demineralizing sea water or oilfield brine, would recharge the groundwater basin but do not involve substantial increases in water quality. These local sources of supplemental water would thus principally benefit agriculture rather than urban users.

The City is also under pressure from the Regional Water Quality Control Board to reduce the amount of minerals discharged into the groundwater basin at the City wastewater treatment plant on Black Road. This can be accomplished by either demineralizing the wastewater or by improving the City's water source. Either alternative is costly.

The City must solve both the long-term supply and quality problems. Imported State Water Project water is presently the lowest cost solution.

It is desirable that the City should plan to keep the quality of its water at or below the federal goal of 500 parts per million

total dissolved solids. This would necessitate importing the City's current State Water Project allotment of 11,300 acre feet per year for current needs and relying upon groundwater or other sources of supplemental water for future growth. The blending of poor quality groundwater with high quality State Water will result in reduced water quality of 500 ppm TDS/300 ppm TH when the City's population increases to 92,000. At current consumption and growth rates, this will probably occur by the year 2000.

Groundwater will have to be demineralized if water quality rises above this limit of 500 TDS. Thus, the City should acquire additional State Water, if available, sufficient to supply its needs at the time State Water is delivered and, if feasible, beyond that time.

The cost of State Water for future growth beyond 1991 should not be borne by current city users. Current users will probably experience a doubling of their water costs as the price of cleaning up the current water supply by using State Water. Such costs will probably quadruple if demineralization, rather than State Water, is used. Current users should not have to pay the substantial additional State Water costs to supply future needs. These costs should be paid by future users.

Water conservation is required by state law and thus should be an important element of the City's long-term water management plan. The City can achieve a 10 percent reduction in water demand through the continued implementation of recently adopted voluntary water conservation measures. An additional 10 percent can be achieved through other measures, such as installation of water saving fixtures, irrigation hardware, review of rate structures, and retrofitting of existing homes. Additionally, educational programs can create a "conservation ethic" in water users. A successful water conservation program may reduce revenues from water sales which may result in a need to increase rates in order to cover costs.

C. Committee Recommendations

Several of the topics that the City Council asked the committee to consider involve the procurement and use of supplemental water. We, therefore, first offer our recommendations on the State Water Project and follow with our general recommendations on the other topics.

1. State Water Project. Our primary recommendation is that the City should obtain as much water from the State Water Project as is economically feasible to help solve both the water quality and quantity problems, as well as to help reduce or eliminate the overdraft. Over the long term, the City should plan to rely upon State Water as its primary source and rely upon groundwater as a supplementary source. This will improve the long-term reliability of the supply and improve the quality of water delivered to city users. State Water is the most economical solution to the City's present water quality problem that will otherwise require

demineralization of groundwater within a few years. It is also the most effective way to solve or reduce the basin overdraft and the severe pumping depression in the Orcutt sub-unit. It is the best way to prevent significant increases in the cost of water to city users in the long run. Water needed for future growth under this overall plan should be paid for by future users. We therefore recommend:

A. The City should obtain and utilize its present State Water allotment of 11,300 acre feet as its primary source of supply in place of the groundwater basin.

B. The City should also seek to obtain additional State Water allotments, if available, in an amount needed to supply the City's entire needs in 1997 or 1998 when we estimate State Water will be delivered. This additional amount should be about 5,000 acre feet per year.

C. If additional State Water is available beyond that which would be needed in 1997-1998, additional allotments should be obtained to provide for future growth. We would estimate that growth for an additional five years would be all that could be financed.

D. The cost of State Water needed for future growth beyond 1991 should be paid for by future users through development fees or other appropriate means.

2. **Water Quality and Degradation.** The quality of groundwater will remain important to the City and all other users in the Santa Maria Valley even if the City utilizes high quality State Water as its primary source of supply. Groundwater will be needed in times of shortage and will be blended with State Water to serve future growth. The quality of the groundwater also affects agriculture, which provides a substantial part of the area economy. It is therefore in the City's interest to assist in preventing further degradation of the groundwater, particularly in the Orcutt sub-basin.

We therefore generally recommend that the City should continue to work closely with and support the governmental agencies having responsibility for preventing groundwater degradation, such as the Regional Water Quality Control Board, Santa Barbara County Health Department, and the Santa Barbara County Water Agency. In this regard, we specifically recommend:

A. Groundwater should be used to supplement State Water during times of need and if needed for future growth. The blend of State and groundwater should not exceed 500 ppm/TDS and 300 ppm total hardness. Even with the City's full allotment of State Water, at present rates of water consumption and population growth, water quality will exceed federal standards by the year 2000. If future growth should cause the blended State and groundwater to exceed these standards, the cost of demineralizing groundwater or obtaining alternative water should be paid by future users.

B. The City should urge the County of Santa Barbara and California Cities Water Company to cooperate in obtaining an increased entitlement to State Water sufficient to meet customer demand at the expected time of delivery. Such high quality water could alleviate the waste water discharge problems of the Laguna Sanitation District as well as significantly reduce overdraft in the Orcutt sub-unit. We believe this is also the most cost effective option when compared to other methods which focus on waste water treatment.

C. The City should continue to pursue the development of an injection well or other suitable alternative for disposal of water softener brines. Restricting the use of new or replacement water softeners to the canister type should be required (for new developments or replacements of existing softeners). Existing home regeneration water softeners more than seven years old should be eliminated or converted to canister type units upon the sale of the property. Rebates or other financial incentives to encourage such a transition could also be explored.

D. The City should require all major brine dischargers to the City sewer system to submit plans to catch and transport brine effluent to an alternate approved disposal facility.

E. The City should continue to fund and vigorously support a household hazardous waste collection program.

F. The City should urge the regulatory agencies to give close attention to the U.S.G.S. salt water intrusion monitoring wells, the landfill monitoring wells, sewer discharge requirements and chemical sources of groundwater contamination.

G. The Water Division of the Public Works Department of the City of Santa Maria should include in its annual report on water quality the following information: a summary of the test results for the City landfill monitoring wells; State Department of Health-required water quality monitoring test results--similar to that required for dissemination to water users; continued use of graphs to show total dissolved solids and total hardness levels; and other water quality information the superintendent feels is important. The report should highlight any anomalies or test results which indicate concern or possible contamination.

3. Overdraft Reduction. The health of the Santa Maria groundwater basin is important to all urban and agricultural water users in the valley. Agriculture is the backbone of the area economy. It is to everyone's benefit that the overdraft be eliminated so that groundwater can become an effective long-term resource supporting the area economy and environment.

The City's proportionate share of the overdraft is small. It is difficult to justify the City's subsidizing the use of groundwater by agriculture and other urban users by reducing the overdraft beyond the City's proportionate share if substantial cost to the City will result. Conversely, given the seriousness of the overdraft, it is desirable, if not necessary, that the

City contribute to reducing the overdraft if little or no cost is involved.

It is fortunate that the City can do more than eliminate its proportionate share of the overdraft by utilizing State Water as its primary source of supply. We believe that utilizing State Water will involve no long-term cost to the City; it will involve cost savings since the cost of State Water is less than demineralization of groundwater.

Even if the City contributes substantially more than its proportionate share of the overdraft reduction by utilizing State Water, it is still in the City's interest to assist further in reducing the remaining overdraft. We therefore, in addition to our conservation recommendations set forth on the following page, further recommend:

A. The City should support reduction of overdraft in the basin and Orcutt sub-unit to the point where average pumpage equals the safe yield.

B. As a long-term solution to overdraft problems in the Orcutt sub-unit, as mentioned earlier, the City should seek to obtain as much water from the State Water Project as is economically feasible in order to reduce its reliance on the basin. We recommend that, in addition to the City's present allotment of 11,300 acre feet (which would be inadequate to supply the City's needs in 1997 or 1998 when we estimate State Water would be available), the City should obtain additional allotments to provide for future growth.

C. The City should urge the County of Santa Barbara, Laguna Sanitation District and Cal Cities Water Company to consider additional State Water as the best long-term solution to the quantity and sewer treatment problems of the Orcutt sub-area. We believe that, if State Water were used as the primary source of supply to the Orcutt area, the overall combined cost of sewer treatment and water supplied to the users would be lower in the long run (as is the case with the City).

D. The City should also continue to support additional measures that increase the yield of the groundwater basin, such as participating in the joint cloud seeding program administered by the Santa Barbara County Water Agency and Flood Control District and encouraging the continuation and expansion of the range management programs and practices of the U. S. Forest Service and the Range Improvement Association.

E. We urge and support the coordination of effort and measures by all basin water users and regulators toward reducing the basin overdraft and maintaining basin water quality. This primarily involves the exchange of knowledge and information about and coordination of the programs, practices and future plans of the various governmental agencies, water purveyors, technical advisors and users. In this regard, we therefore specifically recommend that:

1. The City should encourage the Santa Barbara County Water Agency to create or participate in the creation of a water advisory committee for the Santa Maria Valley groundwater basin to include representatives from the various users and regulators of the water source, both private and public.

2. The City, in cooperation with other interested agencies, should undertake a comprehensive review of the current and long-term water quantity and quality of the Santa Maria groundwater basin, with particular attention to the Orcutt sub-unit.

3. The City, in cooperation with other interested agencies, should create a system of groundwater basin monitoring based on semi-annual well level and water quality measurements. Such a system should include computer modeling of basin water levels and could possibly be funded through a grant from the Department of Water Resources.

4. Conservation. Urban water conservation is mandated by state law. The development and implementation of conservation plans is left to the local purveyors, such as the City.

In general, conservation programs involving the modification of the behavior and use habits of water users tend to be effective in times of crisis (such as drought) and become less effective as the crisis passes. Conservation programs that involve structural changes are more effective in the long term.

The primary effect of conservation in the City would be to help reduce the overdraft. If the City utilizes State Water as its primary source of supply, the conservation benefit to the City, compared to the other users of the Orcutt sub-basin, would be small. This should be kept in mind in considering conservation programs that involve substantial cost or inconvenience to water users.

Conservation programs that eliminate waste and inefficiency are obviously desirable. In addition to reducing the overdraft, such conservation measures save money and resources that can be put to better use. We believe that the following recommendations will help reduce waste and inefficiency at little or no cost or inconvenience:

A. The current water conservation program, including the public information and education program, should be maintained.

B. Automatic landscape irrigation systems, incorporating time clocks and/or soil moisture sensors, should be required for commercial development and common areas of new residential development and encouraged for single family residential development.

C. A residential water audit program should be developed by the City Water Division.

D. The City should contract with a consulting firm specializing in system water audits and leak detection surveys to perform a leak detection survey of the City water main transmission lines.

E. The City should continue to encourage and require the placement of retention/recharge basins. Where appropriate, mitigations could be provided for unique systems or ways to enhance the recharging process. Especially valuable would be areas of high permeability to the east which will provide the most benefit to the Orcutt sub-unit.

F. An ordinance should be developed and implemented which amends the building code to require ultra-low flow fixtures in all new construction. This change is mandated by state law, effective January 1992.

Additional conservation measures involve more cost and the interference with the lifestyle of consumers. Yet, in certain situations these are justified in order to preserve water quality and/or quantity. We feel this may be the current situation in the Orcutt sub-basin; and, in the intervening years before supplemental water is delivered, water conservation by municipal, industrial, and agricultural users offers the only reasonable alternative. Believing that the City should take a leadership role in this regard, while at the same time encouraging other sub-basin users to reduce pumpage, the committee offers the following additional water conservation recommendations which involve structural changes that should be considered if cost effective and justified under the circumstances:

G. The City should pursue a pricing policy which will result in the efficient use of water, such as increasing block, sliding scale, or other scarcity pricing structures. This will probably require an overall increase in rates as conservation results in reduced demand and income, with a resulting need for water rate increases.

H. An ordinance should be developed which requires a water use offset program for new development projects. A condition of approval for new development projects would be to make retrofit changes in existing residences which will offset the new water demands at a ratio of one-to-one. Such changes could include, for example, the installation of ultra-low flow toilets (1.6 gallons per flush) and showerheads using 2.75 gallons per minute, or other effective water reducing measures such as contributions toward replacement of inefficient irrigation systems.

I. The City should examine the feasibility of a rebate program to replace inefficient fixtures.

J. The City should consider requiring efficiency standards for reverse osmosis units that reduce or eliminate water waste.

K. The City should consider utilizing water from its downtown wells at Simas Park rather than the Orcutt sub-basin to provide irrigation for nearby City landscaping, such as at Simas Park, Eastside and Westside Mall, City Hall and Library complex, County complex, Broadway and Main Street medians, and Street Tree water trucks. It should also require contractors to obtain water from that source for construction within a reasonable area of access and perhaps offer a price inducement to offset transportation costs.

L. The City should consider drilling wells for irrigation water at the City Dump, Preisker Park, and any other feasible sites rather than drawing water from the Orcutt sub-basin.

M. The City should investigate equipping each of its water wells with a storage and reinjection pump system to recover the startup water which is currently wasted.

The effect of our recommendations is that the City, over the long term, should plan to rely upon State Water as its primary source of water and rely upon groundwater as a supplementary source. This will improve the long-term reliability of the supply and improve the quality of water delivered to state users. Under this overall plan, water needed for future growth should be paid for by future users.

The recommendations in this section are designed to help implement this overall management plan and increase its effectiveness and benefit. They can be considered individually or collectively depending on the costs and benefits.

II. WATER SUPPLY

A. Introduction

The Santa Maria Valley is fortunate in having the largest and most reliable water supply on the central coast. The underground basin contains less than one million acre feet of water in storage despite many decades of overdraft. This section of the report surveys the current hydrologic balance in the basin and assesses the state of overdraft and concludes with a review of various sources of supplementary water.

The Santa Maria groundwater basin faces a major problem of diminishing quantity and quality of water. During the past 80 years, more than 50 percent of the basin's usable capacity has been depleted or "mined." Estimates based on historical and contemporary well level data show that the basin had over three million acre feet of water in 1918, and today less than one million acre feet remain in storage. This change represents one of the long-term consequences of overdrafting (removing more water than the basin receives). Estimates of the overdraft in recent years have successively increased from 10,000 to 20,000 to 30,000 acre feet per year. In addition, the basin faces a serious problem of deteriorating water quality as total dissolved solids in delivered municipal water approach the 1,000 ppm level, nitrate fertilizers percolate into the aquifer, and toxic wastes or chemicals from leaking underground tanks and landfills threaten public wells. Finally, the threat of salt water intrusion is present and has already begun in the offshore portion of the basin. Continued overdraft will speed its occurrence. The choices made today will either reverse or perpetuate these problems.

B. Santa Maria Groundwater Basin

The Santa Maria Valley relies on the underground water basin as its sole source of water supply and thus its size, sustainable yield, and "health" are important to the quality of our lives and the local economy. This section of the report will outline the basic geographical, geological, and hydrological dimensions of the basin and, based upon the best current information available, estimate its sustainable or perennial safe yield. Such information is a necessary prerequisite to any informed management plan for the basin. This analysis is based primarily upon a review of the following major documents: the 1976 "Santa Maria Valley Water Resources Study" which was contracted by the City of Santa Maria and conducted by the Toups Corporation (Toups, 1976); the 1977 study by the County Water Agency titled "Adequacy of the Santa Maria Groundwater Basin" (CWA 1977); the 1979 "Environmental and Water Resources Reconnaissance Study for State Project Water and Alternatives" by Jones and Stokes for the County Water Agency (Jones & Stokes, 1979); the 1985 "Santa Barbara County State Water Project Alternatives" report by the Department of Water Resources; the 1989 draft of the "Groundwater Resources Section" for the County's General Plan; and the 1990 Coastal

Branch Aqueduct Draft Environmental Impact Report by the State Department of Water Resources (Coastal Branch EIR, 1990).

These reports and studies represent the best available current information on the groundwater basin. However, the information on water recharge and discharge from the basin is far from perfect or consistent. There are many discrepancies, in part due to different techniques or time periods of measurement. The numbers used by the committee in this report are conservative and represent what we consider to be the most accurate estimates.

Basin Geology. The Santa Maria Valley consists of a large U-shaped basin running east to west which, over millions of years, was covered with prehistoric oceans, faulted, uplifted, and filled with sedimentary deposits consisting of sands, clays, gravels, and shales. These deposits, varying in coarseness and thickness, provide the spaces within which a portion of the rainwater which falls on our watershed ultimately finds its way. The most recent geological deposits of sands, gravels, and rocks are approximately 250 feet in thickness and contain significant water. Below these are the Paso Robles and Careaga formations which are also water bearing. It is estimated that, in general, the aquifer averages 1,000 feet in thickness; but much of this is below sea level.

The basin "begins" around Foxen Canyon east of Sisquoc and "ends" anywhere from four to ten miles offshore beneath the Pacific Ocean. It underlies approximately 110,000 acres of valley and foothill land, 30,000 acres of which are in San Luis Obispo County. Approximately 68,000 acres are devoted to irrigated agriculture (Coastal Branch EIR, 1990). The basin watershed is over 1,860 square miles and includes the Cuyama and Sisquoc river drainages which combine to create the Santa Maria River. The primary means of basin recharge is through stream seepage from the Santa Maria River. The permeability of alluvial deposits decreases from east to west due to the fact that, as river deposits were laid down, the finer clays and muds were carried further west than the heavier rocks, gravels, and sands. In fact, 30,000 acres of the western portion of the basin (west of Bonita Road) are essentially "sealed off" (confined) by a clay cap which prevents significant percolation of surface waters into the basin and has created localized perched tables of poor quality water. This must be taken into account when calculating the basin recharge from agricultural irrigation returns and rainfall percolation.

Basin Hydrology. The groundwater basin is a dynamic body of water and has a number of characteristics which are related to its east-west alignment. First, permeability of the alluvial deposits diminishes from east to west, which means that the majority of recharge occurs east of Highway 101. Second, the underground flow of water through the basin goes from east to west with the gradient being steeper in the east and more gradual in the west. Thus, historically the water basin has been "higher" on its eastern half and has flowed "down" toward the ocean where it empties many miles off shore. In fact, the natural

pressure from a relatively full basin early in this century resulted in numerous artesian wells in the Guadalupe area, a groundwater gradient of ten feet per mile, and estimated subsurface ocean outflow of 16,000 AFY (Toups, 1976, pp. 18, 40). Currently the gradient has been reduced to two feet per mile and the outflow to 6,000 AFY (CWA, 1977, p. 45). Overdraft of a coastal water basin, with its resultant reversing of water gradients and off-shore pressures, can easily result in salt water intrusion.

While the basin is divided into various "storage areas," all are interconnected and essentially act as one large aquifer. Movement of water through the underground basin is relatively slow, the probable rate varying between one to three miles per year (CWA, 1977, p. 19). A major pumping depression currently exists in the Orcutt storage unit from which the major municipal and industrial users derive their water. This depression causes steep gradients which draw in surrounding poorer quality water.

Hydrologic Balance of the Basin. This section of the report reviews the various factors related to the hydrologic balance of the basin. The various sources of water recharge, as well as water use, are covered in some detail; and an overdraft estimate for the valley is developed. This overdraft is the difference between the amount of water which enters the basin and the amount which is removed from it.

The Santa Maria basin has been studied in detail for the past 50 years. Even so, the available information contains conflicting or contradictory estimates, incomparable time intervals, and even different definitions of basin size. For example, some studies include the San Luis Obispo portion of the basin in their calculations and others don't. The following table summarizes the size of basin overdraft contained in the major studies and reports we surveyed.

Table I - Santa Maria Groundwater Basin Boundary and Overdraft Amount in Previous Studies

	SLO County Included?	Avg. Yearly Overdraft (AF)
Toups (1976)	YES	8,600
S.B. County Water Agency (1977)	YES	15,000
Jones & Stokes (1979)	YES	19,810
SWP Alternatives (1985)	NO	21,300
S.B. County Resource Management (1989)	YES	21,000
Coastal Branch EIR (1990)*	YES NO	29,500 20,800

*contains each separately

In our survey of existing information, we have chosen what we feel to be the most reasonable and accurate figures available, recognizing that they represent the best existing estimates of the basin's hydrologic balance.

Elements of Recharge. The "supply" side of the groundwater equation has to do with the amount of water recharge that enters the aquifer in an average year. There are three basic sources of such recharge: stream seepage, rainfall percolation, and subsurface inflow. The recharge is extremely important since it is roughly equivalent to the safe yield of our basin. The ability to accurately measure the elements of recharge is not perfected, especially rainfall and subsurface flow. In addition, because each of these variables is determined by the yearly amounts of rainfall, data must be gathered over a long period of time and then a yearly average computed. Different studies of recharge in the basin have used different intervals of measurement which results in varying estimates for recharge. Thus it is important to have data which cover extended time periods but also periods of average rainfall so that a few wet or dry years do not distort the averages.

Stream Seepage. The alluvial deposits in the Sisquoc and Santa Maria River plains are highly permeable, and runoff waters seep through them and into the aquifer. The amount of recharge from this source is calculated by measuring stream flows upstream from the areas of greatest percolation and subtracting from this the measured flows in the Santa Maria River as it empties into the ocean. It is assumed that the differential in amounts of measured water upstream and downstream represents stream seepage recharge. Since all of the rivers and major tributaries are gauged, there is a good data base on which to compute stream seepage.

Stream seepage provides the largest proportion of basin recharge and was significantly increased by the construction of Twitchell Dam on the Cuyama River in 1959. This facility serves the dual function of flood control and groundwater basin recharge. Runoff waters in years of heavy rain are stored behind the dam and then released downstream to percolate into the basin. It is estimated that 20,000 acre feet of recharge are gained through this operation annually.

Stream seepage for the basin has been extensively measured by a number of agencies as well as private consultants. The cumulative results of these studies, taking into account decades of wet and dry years, estimate average annual recharge from this source at approximately 66,700 acre feet.

Rainfall Percolation. This source of recharge consists of direct rainfall onto the basin land surface (as opposed to the watershed) which eventually percolates down through the soil and root zone into the aquifer. A number of variables influence infiltration including permeability of soils, slope, irrigation status, vegetative covering, storm intensity, and depth to water table. These factors make estimates of rainfall recharge more difficult.

The County Water Agency's 1977 study sought to measure some of these factors by categorizing basin land types into irrigated and non-irrigated agriculture, grasslands, and foothills. They then utilized a formula developed by Blaney to estimate rainfall infiltration on these various land types (CWA, 1977, p. 30). Blaney had found in his two field studies (Ventura and Lompoc) that there was no percolation of rainfall to groundwater until annual rainfall exceeded 11 inches on irrigated lands and 17 inches on native vegetation. Thus it would only be in years of above-average rainfall that there would be any appreciable infiltration. In addition, rainfall of over 30 inches resulted in no significant increase of percolation due to soil saturation and resultant runoff.

Based on the above assumptions and taking into account the basin land types and yearly rainfall amounts, the CWA found significantly different rainfall infiltration depending on what yearly interval they used. The 1935-1972 period, which they feel is the most representative, yielded the largest annual average figure of 8,200 acre feet per year (CWA, 1977, p. 48). Changes in land use, specifically the expansion of irrigated farm land, has increased infiltration to an average of 10,500 acre feet per year.

Subsurface Inflow. This factor relates to ungauged, subsurface inflows of water to the basin from the unconsolidated rocks adjacent to it such as the Solomon Hills to the southeast or Nipomo Mesa to the north. In essence, this means rainfall which percolates into the soil outside of the basin and then infiltrates into the basin. This source of recharge is not thought to be significant due to the region's geology and the lack of significant permeability of the uplifted strata surrounding the basin and the high evapotranspiration of the native vegetation covering them. Historical data indicate that this source accounts for approximately 5,000 acre feet of water per year (CWA, 1977).

A conservative review of the data on recharge sources for the Santa Maria groundwater basin is as follows:

Stream seepage	66,700 AFY
Rainfall percolation	10,500 AFY
Subsurface inflow	5,000 AFY
Gross Recharge	82,200 AFY
Subsurface outflow	- 6,000 AFY
Net Recharge	76,200 AFY

When the subsurface outflow (explained in next section) is subtracted, there is a net annual average recharge to the basin of approximately 76,200 acre feet of water per year. This amount represents the "safe yield" of the basin, and any net extractions which consistently exceed this amount will result in an overdraft.

Elements of Discharge. The "demand" side of the equation relates to the ways in which groundwater leaves the basin and is generally much more difficult to accurately estimate than the supply side. First of all, while supply estimates are calculated on long-term averages, demand tends to increase each year and thus is constantly changing. In addition, the pumpage estimates can be inaccurate because there are no meters on agricultural wells. Municipal and industrial usage is more accurately estimated because most of these wells are metered. In addition, water leaves the basin through underground flow which is also difficult to estimate.

When calculating the loss of water to the basin from pumpage, it is important to take into account water returns (return flows). Return flows refer to the amount of water pumped to the surface that percolates back into the underground aquifer and thus is not actually consumed. In order to have an accurate estimate of water actually lost to the basin (called "consumptive use"), the return flows need to be subtracted from the gross pumpage (called "applied water"). The percentage of return flow for municipal and industrial usage in the basin is typically calculated at approximately 33 percent. The figure for agriculture ranges from 20-32 percent. The County Water Agency argues that the 20 percent return flow is probably most accurate due to the confined western 30,000 acres of the basin where irrigation waters cannot penetrate the fine clay strata which underlie the topsoil. The Coastal Branch EIR estimates that 32 percent of the irrigation water returns to the basin. These different return flow estimates from agriculture are just one reason that estimating this source of discharge is difficult.

Agricultural Discharge. Agriculture is the largest user of water, accounting for approximately 80 percent of the basin pumpage each year. Estimates of agricultural usage are based on: (1) the typical water needs of particular crops per acre multiplied by the number of acres under cultivation in the basin; and (2) the amount of electricity used to run water pumps factored by pump capacity, efficiency, and lift height. The estimate of current agricultural pumpage in the 1985 "State Water Project Alternatives" study is 103,000 acre feet per year; the County Resource Management Department's 1989 study of the groundwater basin estimates agricultural pumpage at 109,000 acre feet per year; and the Coastal Branch EIR estimates 1985 agricultural pumpage for the basin at 157,800 acre feet (these figures are for applied water and not consumptive use). In developing our estimate of current agricultural water pumpage, we multiplied 68,000 irrigated acres by 1.7 acre feet per acre applied water factor, which resulted in 115,600 acre feet per year.

Not all of the water pumped for irrigated agriculture is used by the crops or evaporated to the atmosphere. A certain portion percolates back into the basin in the form of "return flows." The actual percentage of return flow is dependent on a number of factors, and general estimates for the Santa Maria basin range from 20 percent (CWA, 1977) to 32 percent (Coastal Branch EIR, 1990). We have chosen to take a middle ground and use 26 percent

as the return flow to the basin from irrigated cropland. We are thus assuming that agriculture "consumes" 74 percent of the water it pumps; 26 percent returns to the basin.

Municipal and Industrial Discharge. Urban and industrial users consume 20 percent of the water pumped from the basin. Data on this usage are more accurate because there are meters on supply wells. The major consumers are located in the City of Santa Maria, the unincorporated Orcutt area, and the City of Guadalupe. The 1989 County Resource Management Department report cited above estimates municipal and industrial pumpage at 22,000 acre feet per year and the "SWP Alternatives" study estimates it to be 26,450 acre feet per year. In a survey completed for this report, the municipal and industrial pumpage for the three major purveyors (Cities of Santa Maria and Guadalupe, Cal Cities Water) totaled 23,203 acre feet in 1989. Private industrial wells' 1989 pumpage included Union Oil (2,000 acre feet) and Holly Sugar (1,841 acre feet). Livestock were assumed to use 1,000 acre feet per year (Toups, 1976 p. 86).

Municipal and industrial water, like that of agriculture, also has a return flow to the basin. This typically takes the form of either treated wastewater or landscape water. Municipal and industrial return flows are estimated to be 33 percent of water pumped, and thus 67 percent is consumed.

Subsurface Outflow. This category refers to the amount of water which flows out of the aquifer at its western edge under the Pacific Ocean. The amount of water flowing into the ocean is a function of the size of the basin (acre feet in storage) and the gradient of the basin, both of which are interrelated. Thus, the more water in storage, the higher the water level and the steeper the gradient, and the more lost to subsurface outflow. This outflow is essential to the health of the basin, as its pressure prevents sea water from intruding into the aquifer and discharges salts into the ocean. Conversely, the lower the water level, the shallower the gradient, the less salts flushed out, and the greater the possibility of salt water intrusion.

A number of agencies and studies have addressed this subject. The Toups study examined overall gradient changes in the basin and concluded that it had been reduced on average to two feet per mile which would result in an outflow of little more than 2,000 acre feet per year. The County Water Agency, building on a U.S.G.S. survey as well as the Toups' study, did a more specialized and in-depth study of the gradient just west of Guadalupe. Their conclusion was that subsurface outflow was 6,000 acre feet per year in 1977. We conclude that the County Water Agency's estimate was more accurate. This outflow would not be sufficient to prevent intrusion, and CWA estimated that a salt water wedge would have penetrated the offshore aquifer by a total of four miles from where it discharged fresh water into the ocean. Monitoring wells at the coast have not yet indicated intrusion to the onshore portion of the basin.

Summary of Hydrologic Balance. It should be clear by now that creation of a hydrologic balance can never be precise. Fortunately, the Santa Maria basin is one which has been extensively studied and thus relatively accurate estimates can be made, although they remain estimates. We have attempted to be both objective and conservative and are confident that the following hydrologic balance represents a reasonable picture of the basin.

Table II
SANTA MARIA VALLEY GWB HYDROLOGIC BALANCE (in acre feet)

A.	Elements of Recharge (average annual)		
	1. Stream seepage	66,700	
	2. Rainfall percolation	10,500	
	3. Subsurface inflow	5,000	
	4. Subsurface outflow	-6,000	
	Total	76,200	safe yield
B.	Elements of Discharge (consumptive use 1989)		
	1. Irrigated agriculture	85,544	
	2. Livestock	1,000	
	3. City of Santa Maria	8,356	
	4. Calif. Cities Water Co.	6,593	
	5. City of Guadalupe	892	
	6. Holly Sugar	1,841	
	7. Union Oil	2,000	
	Total	106,226	
C.	Average Annual Overdraft	30,026	

The amount of available water in storage within the basin and the size of the overdraft combine to provide a prediction of how many more years of water are available. The Coastal Aqueduct EIR (p. 203) estimates there to be approximately a million acre feet of usable water in the Santa Maria basin with an average annual overdraft of 30,000 acre feet--approximately 30 years' supply.

John Alroth, hydrologist with the County Water Agency and expert on the basin, believes there are approximately two million acre feet currently in storage, an all time low according to his data, which go back to 1918. This is considerably more than the Coastal Branch EIR estimate of one million acre feet. However, Alroth also believes that any pumping past the 1.5 million acre foot level would be of serious consequence, including salt water intrusion, large numbers of dry wells, and very degraded water quality. This means only 500,000 acre feet of usable water would remain in storage. With the continuation of a few more dry years, the basin could be in a serious situation. Alroth assumes the annual overdraft to be closer to 20,000 acre feet per year (personal communication). Our independent review of the various studies resulted in an annual overdraft estimate of 30,026 acre feet, similar to that found in the EIR. Despite their differences, all of these estimates point to the same conclusion--continuing the current rate of average overdraft leaves 15-30 years of available water basin wide.

Unfortunately, the past five years have been below average in rainfall, and the resulting drought has meant little or no recharge of water into the basin. This means that the annual overdraft for the past few years has been closer to 100,000 acre feet, which explains the all time low levels of many wells in the valley. In the very best of wet years, the basin can gain 300,000 acre feet in storage. These are very rare. It typically takes a series of wet years to create significant recharge.

Orcutt Sub-Unit Hydrologic Balance. The Orcutt sub-unit of the basin has historically contained the best quality water (low in total dissolved solids and hardness), and thus the majority of municipal and industrial water supply wells are located there. Over the past 20 years, the amount of pumping from this sub-unit has significantly increased well beyond the safe yield (Toups, 1978), resulting in a relatively large overdraft.

Return flows from pumpage in the Orcutt sub-unit are generally thought to be negligible for two reasons. First, the underlying geology is characterized by many clay lenses which prevent the direct percolation of surface water into the aquifer. Second, the M&I wastewater is transported away from the sub-unit to treatment plants on its periphery. Thus, in calculating the hydrologic balance for this sub-unit, we have treated all pumping as consumptive--that is, we assume no return flows to this sub-unit. Of course, on a basin-wide scale, some of these waters do return to the aquifer in the form of return flows. These return flows are not included in the calculation of the overdraft figure given in Table III below.

Table III
Orcutt Sub-Unit Hydrologic Balance

	AF Consumed in 1989	
Agriculture (est.)	7,000	
City of Santa Maria	12,471	
Cal Cities	8,769	
	28,240	AF total
	-9,670	AF (annual safe yields)
	18,570	AF ANNUAL OVERDRAFT

This overdraft has created a local depression in the basin water level of 60 to 80 feet below which it would normally be. Water from the surrounding areas, including those beneath the wastewater treatment plants, is thus drawn into the depression in an attempt to fill the void. This water is typically of poorer quality (high in TDS and hardness).

The continuing and increasing overdraft further exacerbates the depression, hastening the flow of poor quality water in an ever-worsening quality spiral. Eventually, water will need to be demineralized before delivery to consumers.

As the pumping depression increases, the ability of the sub-unit to be recharged from the surrounding area at a rate which will continue to provide water for municipal and industrial wells becomes more critical. In other words, the underground flow of water in the aquifer may not be rapid enough to replace that which is pumped out. This would result in precipitous drops in well water levels and loss of productivity, with wells ultimately going dry. Issues related to addressing these problems are contained in other sections of the report (Overdraft Reduction and Water Quality).

C. Alternative Water Sources

State Water Project. The California State Water Project is a water storage and delivery system of reservoirs, aqueducts, power plants and pumping plants. It extends for more than 600 miles--two-thirds the length of California. Planned, built and operated by the California Department of Water Resources, it is the largest state-built, multi-purpose water project in the country. The Project's main purpose is water supply - that is, to store surplus water during wet periods and distribute it to areas of need in Northern California, the San Francisco Bay Area, the San Joaquin Valley, and Southern California. Other project functions include flood control, power generation, recreation, and fish and wildlife enhancement.

The basic operating plan for the State Water Project is for the state to build and operate the dams and aqueducts necessary to deliver the surplus flood waters of northern California to the water users in the south. There are 30 agencies, including Santa Barbara and San Luis Obispo Counties, who have contracted with the state to take and pay for project water. Under the contracts with the state, the water users are required to pay all of the costs of building and operating the project. The main storage and transportation facilities were built in the 1960s and 1970s.

The contract with San Luis Obispo and Santa Barbara Counties provides that these counties must pay their pro rata share of the cost of constructing the main storage and transportation facilities in the Sacramento and San Joaquin Valleys. However, they were not required to commit to the construction and operation of the coastal branch of the State Water Project until 1975 (since extended to 1991) when it was expected that the water would be needed. It is unlikely that the deadline to obtain State Water will be extended beyond 1991. Thus, State Water will be available only for a short time and, if not taken, will be lost as a source of supplemental water.

The proposed coastal branch, Phase II, is an 87-mile buried pipeline extending from existing State Water Project facilities in Kern County to the Santa Maria River with associated pumping and power recovery plants. The proposed 23-mile Mission Hills extension would deliver a projected 27,723 acre feet per year to Santa Maria, Guadalupe, Orcutt, Vandenberg AFB, Vandenberg Village, Mission Hills, and Lompoc.

The costs of State Water are substantially more than the current cost of groundwater. The cost of local groundwater is estimated by DWR to be $150 per acre foot. Final State Water costs will depend on the amount of water contracted for by water purveyors in Santa Barbara and San Luis Obispo counties. The latest estimate (December 1989) of the cost of State Water, delivered at the turnout to the coastal branch terminus in Santa Maria for the downsized project, is $530 per acre foot. The cost of treatment will add $110 per acre foot, so the total cost is estimated to be $640 per acre foot of water delivered into the City facilities. Costs would be slightly lower if additional water is taken beyond current entitlements. Costs could increase in the future if energy, repairs, maintenance, and the cost of additional storage facilities increase. The cost will also decline in the future as the bonds used to finance the capital costs are paid off.

An attractive feature of State Water for the City is its high quality. The contract guarantees water quality to average over a ten-year period no more than 220 parts per million total dissolved solids. If the peripheral canal or a similar delta transfer facility is constructed, the average quality will be substantially better, probably in the range of 100 parts per million.

Relying on State Water is not without risk. At the present time, the state project cannot guarantee delivery of contract water during periods of extended drought.

The State Project has contract obligations to deliver 4.2 million acre feet per year. This amount can easily be delivered during wet and normal years. However, during periods of extended drought (such as the present), the project has the capacity to deliver about 2.5 million acre feet. It is possible that deliveries will be curtailed during periods of extended drought in northern California. If necessary, deliveries of State Water for agricultural use will be cut in half prior to any municipal/industrial reductions. Fifty percent of the State Water Project (or approximately 2 million acre feet) is contracted by agriculture. Reduction of deliveries to urban users has not yet occurred, although they are contemplated for 1991. If reductions occur in the future, they will be small and infrequent for urban users.

State Water is presently conveyed from the Oroville Reservoir on the Feather River through the Sacramento River and Sacramento/San Joaquin River Deltas to the State Water Project. The State Water Project capacity deficiencies will be largely solved by the construction of the peripheral canal and other water conservation projects. The peripheral canal would take the high quality water around the Delta so that it would not be mixed with Delta water. The peripheral canal would also increase the capacity of the state project by about one million acre feet. If the peripheral canal is constructed, the state project will become very reliable and the water quality will be substantially better than now guaranteed by the contract.

Even if the peripheral canal is not built, State Water is still the most economical solution to the City's long range water problems, considering the expected need to demineralize groundwater in the future. The use of State Water to supply the City's needs, supplemented with groundwater during any periods of curtailment, will provide a reliable supply of good quality water at the least cost. Construction of the peripheral canal will improve both the reliability of the system and substantially improve water quality.

Given the fact that two-thirds of the state's population relies on State Water, we believe it likely that the peripheral canal will be built in the future. We believe that it is a reasonable gamble for the City to assume that the additional benefits conferred by the peripheral canal or other delta transfer facilities will be available if the City contracts for State Water.

Desalination of Sea Water. In the past, desalination of sea water has been developed only in special cases because of its high energy cost. However, the technology to desalt water has improved and, as the cost of other water supplies increases, desalination of sea water is becoming more competitive as an alternative water supply.

DWR has been evaluating the role that desalination of sea water and brackish waters can play in providing a part of California's water supply. There are no significant technical problems in obtaining fresh water from sea water by desalination. Large quantities of fresh water for municipal use are provided by this means in several parts of the world where natural supplies of fresh water are in short supply and desalination of sea water is the lowest cost alternative means to provide a water supply. The improvements in technology tend to reduce the cost of sea water desalination. However, the effects of inflation and increased cost of energy have had a net effect of increasing the costs, and energy cost does impact desalination costs more than the other alternatives. It is not possible to accurately predict how these factors will influence the future cost of desalting. The Coastal Branch EIR estimates desalination costs at $2,140 per acre foot. Because the projected water demand in Santa Maria sub-area indicated a need for more water than is available locally, desalination of sea water is a potential source for part of its future water. Costs for the desalination of sea water in the Santa Maria sub-area would also include the costs of pumping desalted water from the ocean and would thus be substantially more than $2,140 per acre foot.

Weather Modification. Although the physics of clouds is not completely understood, it is known that several conditions are necessary for precipitation to occur. As cloud droplets rise to high altitudes, they become supercooled. Unless various impurities in the atmosphere are present which can serve as ice nuclei, supercooled water droplets may remain liquid at temperatures down to -40 degrees Centigrade (Henningson 1975). Silver iodide is an artificial nucleating agent that will induce the freezing process at a warmer temperature than would occur with naturally occurring

nuclei. The conversion of cloud droplets to precipitation is facilitated because silver iodide particles provide for ice crystal growth. The heat release resulting from ice crystal formation (change in state from liquid water to solid ice) creates new buoyancy and enhances up-drafts, resulting in further dispersion of the silver iodide. Silver iodide may be either dispersed from aircraft or generated as a smoke from the ground. Cloud seeding has been carried on in Santa Barbara County, including the watershed of the Santa Maria Valley, for many years.

Santa Barbara County contracts for cloud seeding on behalf of 11 county water purveyors. Costs are shared on a 50/50 basis between the County and the water purveyors. A cloud seeding program is generally pursued on a yearly basis, although there are occasional years where the program is halted due to meteorological conditions. The County utilizes an aerial program for the most part and supplements that with ground-based cloud seeding. Costs for 1990 were estimated at $190,000 and included both aerial and ground-based cloud seeding. Intensive cloud seeding programs yield long-term annual rainfall increases from 10 - 15 percent over that which normally could be expected without cloud seeding. The cloud seeding program should be continued for as long as it is cost effective. We believe the effect of cloud seeding is included in calculations of the overdraft of the Santa Maria Valley groundwater basin. Thus no additional water should be expected from this source without further technological advances. Weather modification in the Santa Maria area should not be relied upon as a source of additional water in the immediate future. Weather modification should be considered only as a source of additional groundwater in wet years.

Watershed Management. One method of increasing the amount of water that reaches the Santa Maria groundwater basin is through the management of the watershed vegetation. This is done by the periodic burning of brushlands and forest areas in mountainous areas that form the watershed that feeds the Cuyama and Sisquoc rivers. Areas that annually receive more than 15 inches of rain per year have the greatest potential toward providing significant runoff. Those areas are largely located at higher elevations within Los Padres National Forest located east of the Santa Maria Valley. This National Forest watershed area involves approximately 360,000 acres. According to National Forest data, the average annual amount of water that drains from this watershed is 53,000 acre feet. The majority, 36,000 acre feet, runs into the LaBrea and Sisquoc rivers while the remaining 16,300 acre feet flow into the Cuyama River. These flows are from national forest land only, most of which is in the Sisquoc River watershed and do not include flows from private property.

The current commitment of the Forest Service toward watershed management is to burn 3,000 acres per year. Whether this is achieved depends largely upon funding and the occurrence of acceptable climatic conditions in which to do this burning. The Forest Service indicated they would like to increase this program to burn an average of 6,000 acres per year which would manage one-half of the watershed on a 30-year rotation basis. It is

estimated that this would increase the amount of runoff by approximately four percent. This would yield an additional 2,125 acre feet per year. Of this amount 1,473 acre feet would flow into the Sisquoc River while 625 acre feet would flow into the Cuyama River.

The Range Improvement Association has a conversion type burn program. This converts brush to pasture on a permanent basis. The expansion of this type of program could result in significant increases in runoff. However, this type of burning is done on private land adjoining the National Forest, usually in the lower elevations of the watershed. The Wellman fire of 1966 burned approximately 93,000 acres within the National Forest which increased the water runoff in the years following the fire. Watershed management should be encouraged so as to benefit the groundwater basin; however, it is not an economical or reliable source for urban users.

Twitchell Dam. Another source of additional water is the use of Twitchell Reservoir flood control capacity for water conservation purposes. Twitchell Reservoir is a combination flood control and water conservation project. The total storage capacity of 239,000 acre feet is allocated 150,000 acre feet to water conservation and the top 89,000 acre feet to flood control. When water is impounded in the flood control portion of the reservoir, the operation of the dam is controlled by the U.S. Army Corps of Engineers. The Corps requires that water impounded in the flood control pool be released as soon as possible so as to maintain flood control protection at all times.

In recent years, the Corps of Engineers has allowed the Santa Maria Valley Water Conservation District to encroach on the flood control portion of the reservoir late in the rainy season when the danger of floods has passed. Additional water was stored in 1969, 1979, and 1983 resulting in additional groundwater recharge. This is not a firm source of additional water because it is not available during times of flood danger. Additional storage will only occur during wet winters when substantial runoff occurs after the danger of severe floods has passed. The City's position should be to encourage the use of flood control storage for water conservation purposes late in the winter when the danger of floods has passed.

Spreading Basins. The construction of spreading basins in and adjacent to the Santa Maria riverbed to capture runoff from the Sisquoc River is another source of additional water. The Santa Maria Valley Water Conservation District previously constructed and maintained such basins. These basins slowed the river flow and spread river flow over a greater area so as to increase percolation into the groundwater. These basins have been removed because they created a threat to the levees protecting the Santa Maria Valley from flooding.

Preliminary engineering studies have determined that it would be possible to construct percolation basins offstream and south of the Santa Maria levees. This would eliminate the danger to the

flood control levees. It has been estimated that the cost of facilities would be $2.5 million (1979 dollars) and the annual cost of maintenance would be $245,000 (Santa Barbara County Water Agency). The estimated annual yield to the groundwater basin is 3,500 acre feet at $118 per acre foot in 1979 dollars.

Round Corral Dam. Construction of a dam at the Round Corral site on the Sisquoc River is another possible source of additional water. Such a dam would provide between 6,000 and 7,000 additional acre feet of water per year at an estimated cost in excess of $1,000 per acre foot. Lower costs, or additional demand for water, would be required before such a project would be feasible.

Practically all local sources of additional water would involve groundwater recharge projects. Agriculture would be the primary beneficiary of any groundwater recharge project. Urban and industrial users consume about 20 percent of water produced from the Santa Maria Valley groundwater basin. It is therefore unlikely that the City, or any other urban user, would or should initiate a groundwater recharge project. The City's policy should be to encourage and assist in the institution and implementation of groundwater recharge projects when they become feasible and economically beneficial to the City.

III. WATER DEMAND

A. Introduction

This chapter surveys many of the issues related to water demand in the basin including both urban and agricultural use. It assesses the relationship between population growth in the City and water demand as well as various strategies for overdraft reduction. Both water conservation and supplemental sources are examined. Additionally, the quality of delivered water and its relation to population size is also discussed. Finally, the financing of water supplies for future users is explained.

City of Santa Maria water pumpage for 1989 was 12,471 acre feet; this served a population of roughly 53,000 as well as a varied mix of commercial users. Population projections, as provided by the Santa Barbara County-Cities Area Planning Council "Forecast '89," estimate a population of 78,203 in the year 2005. The City of Santa Maria is presently conducting a sphere of influence study.

B. Water Resources and Population Growth

As part of its long-range water management plan, the City has an obligation and responsibility to provide sufficient water for anticipated future growth. This section of the report reviews the future water needs of the City in relation to population growth, the potential impact of new water supplies on population growth, the use to which new sources of water should be put, and how water supplies for future anticipated growth should be financed.

The economy and population of the Santa Maria Valley are being supported through the unsustainable use of groundwater resources. This situation can continue for a few more decades, given current supplies and rates of use (the Coastal Branch EIR estimates 30 years). Eventually as supply and quality decrease, competition for water will increase, with agriculture most probably being the greatest loser. Supplementary sources or new treatment facilities will be necessary to meet municipal and industrial needs.

Water Needs and Future Growth. The City of Santa Maria has experienced dramatic population growth over the past ten years, as can be seen in Table IV on the following page.

Table IV - City of Santa Maria Population Growth

	Population	Dwelling Units	Persons Per D.U.
1980#	39,685	15,018	2.642
1990*	61,284	21,173 (+40%)	2.894

State Department of Finance
* 1990 U.S. Census

A continuation of this growth rate would mean a city population of 94,377 in the year 2000 and 145,341 by 2010. Proposed annexation and zoning changes over the next decade may allow for at least an equal number of new dwelling units as those created in the past decade. Other population growth estimates from the Area Planning Council, the State Department of Finance, and the Coastal Branch EIR all indicate increased population for Santa Maria over the next 30 years.

Growth predictions are always problematic, based as they are on a number of unknown future factors such as migration from other areas, the availability of employment, and the growth policies of neighboring jurisdictions. Nevertheless, unless there is clear evidence to the contrary, it is good planning to assume that additional growth will continue in the Santa Maria Valley.

Under current zoning, 100 percent buildout of the residential areas would result in a population of 78,315. The Sphere of Influence Administrative Draft EIR contains projections for population under three different zoning scenarios - these would result in city populations of 89,911; 105,662; and 114,847. Therefore, the estimates for population growth range from a low of 78,315 to a high of 114,847.

The amount of water the City will need to serve future population growth is related to: (1) the size of the population and (2) the efficiency with which water is utilized. For example, the same amount of water can support a larger or smaller population depending on how conservative or careful households and industries are in their use. Table V on the following page shows this relationship quite clearly.

This table indicates the various quantities of water necessary to serve different population sizes at different rates of per capita use. The current per capita use rate of .21 acre feet per year, if continued into the future, will require significantly more water compared to a reduced per capita use rate of .17 acre feet per year (which we assume could be achieved through water conservation). This table can be used by planners and policy makers to predict needed water quantities to serve a particular population size at a particular rate of use.

TABLE V

POPULATION SIZE
AND
ANNUAL WATER DEMAND

CITY POPULATION	.17**	.18	.19	.20	.21*	.22
110,000	18,700	19,800	20,900	22,000	23,100	24,200
105,000	17,850	18,900	19,950	21,000	22,050	23,100
100,000	17,000	18,000	19,000	20,000	21,000	22,000
95,000	16,150	17,100	18,050	19,000	19,950	20,900
90,000	15,300	16,200	17,100	18,000	18,900	19,800
85,000	14,450	15,300	16,150	17,000	17,850	18,700
80,000	13,600	14,400	15,200	16,000	16,800	17,600
75,000	12,750	13,500	14,250	15,000	15,750	16,500
70,000	11,900	12,600	13,300	14,000	14,700	15,400
65,000	11,050	11,700	12,350	13,000	13,650	14,300
60,000	10,200	10,800	11,400	12,000	12,600	13,200

YEARLY PER CAPITA WATER USE (AF)

* Represents current per capita water consumption.

** Represents a 20% reduction in water consumption.

Water Quality and Future Growth. In addition to water quantity issues as discussed in Chapter II, the City faces a much more immediate water quality problem. Basically it has two options in dealing with the problem: (1) demineralize groundwater when it reaches the maximum allowable limits for TDS or (2) develop an alternative source of high quality water such as the State Water Project. The importation of State Water is presented by some as the ultimate solution to the City's water quality problems, but this is not the case.

The City's current State Water Project entitlement of 11,300 acre feet per year is not sufficient to meet current yearly water demand, and thus a certain amount of groundwater would still need

to be pumped. At current rates of per capita use, State Water could support about 52,000 persons, 9,000 less than the existing population. The blending of State Water with groundwater in order to meet urban demands will also impact on the quality of delivered water. Because local water is of very poor quality, any blending of it with State Water lowers the quality of delivered water. As can be seen in Table VI, the TDS levels in blended State and local groundwater delivered to city users increases as more groundwater is used.

Table VI
POPULATION LIMITS AS A FUNCTION OF DELIVERED WATER QUALITY
(TOTAL DISSOLVED SOLIDS (TDS) AND TOTAL HARDNESS (TH)

TDS/TH Level	%SWP/AFY	%GW/AFY	Total AFY	Pop. Size
500/300 ppm	57%/11,300	43%/8,524	19,824	92,033
400/240 ppm	70%/11,300	30%/4,824	16,124	74,856
300/190 ppm	80%/11,300	20%/2,825	14,125	65,576

Population size is calculated using .2154 AFY per capita consumption (past ten-year average).

Source: 1987 Santa Maria Urban Water Management Plan: Table 1 & Figure 9.

The committee recommends that, if the City is successful in acquiring its allotment of State Water, it should plan to deliver water at a TDS level of no more than 500 ppm to its customers. Water delivered at a TDS of 500 ppm (the maximum recommended federal drinking water level) would mean the City could support a population of 92,033 persons at current water consumption rates. The City would then need to pump 8,524 acre feet of groundwater (about 75 percent of its current pumpage) to blend with the 11,300 acre feet of State Water. By the year 2000, at current growth and water consumption rates, the City will have exceeded federal water quality standards.

If the City continues to grow at the rate of the past ten years, it will have a population of 94,377 persons by the year 2000; and the quality of delivered blended water will most probably have gone above the 500 ppm level. In addition, significant amounts of groundwater from the Orcutt sub-unit will continue to be pumped and the overdraft situation perpetuated. Also, the groundwater would need to be demineralized in order to maintain the quality levels regarding TDS. Of course, to the extent that individuals and organizations reduce their water consumption, the amount of population which can be supported with a given amount of water increases.

Population Growth with Existing Water Supplies. As other sections of this report make clear, the basin as a whole--and especially the Orcutt sub-unit--is being seriously overdrafted. Thus, any increased pumpage only increases the overdraft; and to the extent that an increased population will demand more water, such growth will increase overdraft. If the City's policy or

governmental mandate is to reduce overdraft and create a long-term, sustainable, safe yield from the basin without importation of supplemental water, then increased pumpage is an unacceptable alternative. In this case, new development and population growth could only take place with greatly improved water use efficiency and conservation or by urbanization of irrigated farm land. In other words, new development could only take place if it did not increase the overdraft. This could only be accomplished through an aggressive water conservation program (the possible elements of which are outlined in a separate section of this report) or by displacing irrigated agriculture which uses more water per acre than urban use.

However, in view of the extreme overdraft of the Orcutt sub-basin where the City derives virtually all of its water, it is likely that this source will be depleted long before the basin as a whole. Unless the major pumpers are willing to reduce their use to safe yield levels (9,670 acre feet per year), the overdraft will continue. Such reduction is very unlikely, given that M&I 1989 pumpage was over 21,000 acre feet. In addition, continuing the overdraft will also accelerate the degradation of water quality. It is therefore likely that, even if there were no future growth, the City would have to obtain additional water (perhaps through condemnation of agricultural water rights) as well as demineralize the groundwater. Both of these options would increase the cost of water and perpetuate the overdraft and quality problems.

If existing water supplies are to be used to support future growth, the result will be eventual depletion of the basin. This will result in apportionment of the water shortage among the basin users, which will occur through either attrition on the part of agriculture, legal adjudication of water rights, or creation of a groundwater basin management district. Less groundwater will thus be available to the City. This shortage will have to be made up through mandatory conservation or by acquiring additional rights to agricultural water through condemnation. In the long run, a substantial portion of the cost of water for growth would be paid by existing users.

Population Growth with Supplementary Water. Realizing the serious nature of our deteriorating water quality and quantity, the City of Santa Maria has been involved in the process of attempting to acquire 11,300 acre feet of State Water Project water for a number of years. This relatively high quality water, imported from northern California, would be used to supply a significant portion of its municipal water requirements. In addition to helping alleviate the poor water quality problem, it would also significantly reduce the basin overdraft, particularly in the Orcutt sub-unit.

The potential for such a new source of water to induce population growth has been a controversial question in Santa Barbara and San Luis Obispo counties in recent years. In geographical areas with ample water supplies such as the Pacific Northwest, this resource is rarely a factor in economic development (and thus population

growth). In semi-arid areas, the availability of water can be a factor in economic development. The question of the growth-inducing consequences of new water supplies in semi-arid regions is controversial and one which the recently completed Draft EIR on the Coastal Branch Aqueduct specifically addresses. The EIR concludes that supplemental water will not necessarily induce additional urban growth unless it can be shown that such water would create structural shifts in a region's economy and thus stimulate future economic and population growth. There is no evidence that the importation of State Water would create any such structural shift in the Santa Maria Valley's economy.

A second factor related to the growth-inducing potential for State Water is its impact on current water supplies. When such water is used to replace water currently pumped from an over-drafted basin, as it would be in Santa Maria, then it should not be growth inducing. In other words, every acre foot of new water would mean an acre foot no longer pumped from the basin or, in the words of the EIR:

> ...if the project's yield is used in addition to current surface and ground water supplies, then the resulting growth-inducing impacts would be different than if the yield were used to replace existing supplies, such as over-drafted ground water basins (p. 114).

Since State Water would be used to replace poor quality Orcutt sub-basin water and thus reduce the overdraft, it should not, in and of itself, encourage population growth.

The committee thus concludes that State Water would not have population growth-inducing impacts in Santa Maria. The fact is that there exists enough groundwater in the valley to support almost unlimited urban growth if such water were taken from other users (primarily agriculture). The costs of such water would be relatively high, involving condemnation and purchase of agricultural water, demineralization of water, and increased pumping costs. Furthermore, if additional groundwater is not available, sea water desalination, though costly, is available.

Financing Future Water Costs. The City's water policy with regard to population growth should be to provide future users with the best quality water at the lowest cost and should not attempt to restrict the supply of water to restrict growth. However, the cost of water for future growth such as additional allotments of State Water, should not be paid for by current users. In planning for growth, the City should investigate various methods to finance future water quantity and quality needs such as bonds or certificates of participation. The cost of this financing would be repaid through assessments or development fees charged to the users. We are not competent to address the details of such municipal finance issues, but we strongly recommend that they be seriously and thoroughly considered.

We recognize that, if future users of water must pay the substantial costs associated with acquiring and/or treating additional water, such costs could possibly decrease future growth. The extent to which this is likely would depend on a number of variables that are difficult to predict.

C. Agricultural Water Use

Estimates of agricultural water use are derived by multiplying crop acreage projections (which include double-cropping estimates) by estimated crop water requirements. The Coastal Branch EIR estimates 1985 agricultural consumptive use of water at 82,500 acre feet, and we estimate 1989 usage at 85,544 acre feet. Projections in the Coastal Branch EIR for the year 2010 show acreage decreasing only slightly while the water requirement of various crops decreases by 12 percent, resulting in an overall decrease in consumptive use to 72,600 AF or 16.7 percent. These declines are attributable to two factors: 1) a shift in cropping patterns away from high water using field crops to lower water using vegetable, nursery, and citrus crops, and 2) increasing irrigation efficiency. Examples of agricultural irrigation efficiency efforts include improved technological support of crop water needs, more uniform application of applied water, better scheduling of irrigation, tailwater recirculation, land leveling, and drip irrigation. We question whether such a shift in cropping patterns will occur.

Several unknowns could have a significant impact on agricultural water demand. One is increasing crop production through the development of marginal farmland for intensive cropping, such as strawberries. The other unknown is greater water conservation through use of new techniques developed by the Soil Conservation Service, Resource Conservation District, and University Extension. There is an incentive to save water and reduce costs through programs such as Pacific Gas and Electric's energy rebate programs. More efficient use of water translates into lower pumping costs. At this point, it is still unclear in which direction agricultural water demand will go.

IV. BASIN OVERDRAFT

A. Introduction

As part of its charge to this committee, the Council asked "How can the City contribute to the replenishing of the Santa Maria Valley groundwater basin?" While the answer is simple--reduce the pumpage from City wells--its accomplishment will be more difficult. This section of the report reviews various approaches to this question.

The best available information on the Santa Maria Valley groundwater basin indicates that there is less than 30 years of usable water (especially for agriculture) available, assuming average rainfall and no increase in water extractions. Continued drought and increased pumpage can shorten these times considerably. The consequences of such a depletion would probably include the reduction of irrigated agriculture, salt water intrusion, greatly increased water treatment costs, and economic dislocation. No reasonable person who cares about the long-term economic health of the valley would want to see such a situation develop. On the other hand, the City accounts for only 7.9 percent of the water pumped in the basin and thus should not be expected to shoulder an unfair responsibility for reducing the overdraft.

While it is quite common for communities to wait until problems are almost overwhelming before they seek to do something about them, we are in a favorable position with regard to the overdraft issue. We have a very clear picture of the past and accurate projections into the future. We also have the experiences of other areas which have chosen to ignore coastal groundwater overdraft and are suffering the consequences. For example, the Oxnard plain, a geographical area very similar to our own, had been overdrafting its basin for years. Currently over 22 square miles of the underground aquifer have been inundated with ocean water which is progressing at the rate of two miles per year--despite a multimillion dollar federal and state effort to halt it. In addition, the entire basin has been put under the control of a management district with the mandate of reversing the overdraft. All pumping by agriculture and municipalities is strictly metered and controlled, with required sequential reductions for the next ten years.

The Santa Maria Valley is in a unique and enviable position. We have a relative abundance of usable water while our neighbors to the north and south experience severe water use restrictions and expensive alternative sources. We are also in a position to begin the process of creating a coalition of self-interested groups and individuals who want to preserve the long-term economic value of this water resource. There is no need for Santa Maria to ever find itself in the situation of Oxnard. We recognize that the solution to the overdraft will be some time in emerging and will not be without difficulty. It will take cooperation and compromise. Most importantly, it will take the will to make voluntary

changes before market and environmental forces leave us with no alternative. In short, we are in a position to voluntarily do now what in the future we will have no choice in--preserve for long-term economic security the largest and most dependable water resource on the central coast.

B. Overdraft Reduction

There are two strategies available to the City to reduce the amount of its pumpage. The first emphasizes water conservation and thus a lowering of actual demand for water. The prospects of such reduction in the short run are quite good. City residents currently have a very high per capita use, there is significant loss in the distribution system, water rates offer little economic incentive for conservation, and a "water saving consciousness" has yet to permeate the city as a whole. Thus an assertive yet reasonable conservation policy and program could probably effect a 20 percent reduction in current demand (see the section of this report on Conservation). However, future city demand for water is sure to increase if the rapid population growth of the past 10 years (54 percent) continues into the future. Planned and proposed land use and zoning changes could easily add another 50,000 persons over the next 20 years. Thus in the long run, although sophisticated water conservation will be an absolute necessity, a growing population would entail some amount of increased pumpage and overdraft.

A second option to reduce pumpage is that of developing some supplementary source of water (i.e., the State Water Project, desalination, Round Corral Dam, etc.) which would be used in place of groundwater. Currently three valley purveyors (Santa Maria, Cal Cities, Guadalupe) have reservations for 15,000 acre feet of water from the State Water Project. This water would do much to reduce the current overdraft in the basin and would be particularly helpful in the Orcutt sub-unit. It will not, however, in and of itself, eliminate the overdraft. Other major pumpers of groundwater will also have to do their part.

The committee is well aware that overdraft reduction is a complex political and economic issue. It is our hope that valley water users will be able to come together in a cooperative and voluntary effort to reduce the overdraft and create a long-term sustainable yield of groundwater. The overdraft cannot continue indefinitely, and anyone with a long-term economic investment in the valley has a clear self interest in reducing it. While this is especially so for agriculture, with its need for large quantities of water, it is also true for the business person and homeowner.

Assuming that the "political incentive" necessary for such an effort were to emerge, how might a group go about developing a set of goals for reduction of water use in the valley? One method might be to determine what each of the major users share of the basin wide overdraft is. This is simple enough to estimate

given our knowledge of current pumpage and the size of the overdraft. For example, with the overdraft at 30,026 acre feet and the City's share of basin pumpage being 7.9 percent, then their "share" of the overdraft would be 2,372 acre feet (.079 x 30,026). Table VII below shows what these figures would look like for other major water users.

Table VII
PROPORTIONATE SHARE OF BASIN OVERDRAFT
BASED ON SHARE OF 1989 BASIN PUMPAGE
(30,026 AF Overdraft)

	AF Consumed in 1989	Percent of Pumpage	Share of Overdraft (AF)
Agric.	85,544	80.5	24,171
SM	8,356	7.9	2,372
CalCit	6,593	6.2	1,862
Guad	892	.8	240
Others	4,841	4.6	1,381
	106,226	100.0	30,026

The committee does not present these figures in any sort of prescriptive manner but rather as "water for thought" to those who would seek to develop a long-term solution to the overdraft. We recognize that actual water use reductions will have to take into account such specific factors as costs per acre foot conserved, economic consequences of conservation, etc.; and thus a perfectly "equitable" distribution of overdraft reduction may not be fair or reasonable. For example, it is obvious from Table VII that the City of Santa Maria, if it obtains 11,300 acre feet of State Water, will be doing far more than its "fair share" in addressing its part of the overdraft for the basin as a whole.

However, the City faces a larger problem of overdraft reduction when we focus our attention on the Orcutt sub-unit of the basin. This part of the basin has historically had the best water quality because its recharge has depended more on rainfall percolation and inflow from the southeast. This explains why the City of Santa Maria and Cal Cities Water Company have located their wells there. Consequently, this sub-unit has been subjected to heavy M&I pumping which in turn has created a lowering of the water level as well as a significant deterioration in water quality.

The serious consequences of this overdraft for both quantity and quality of water were reviewed in the Groundwater Basin section of this report. Either problem is significant enough by itself; their simultaneous and interactive nature calls for serious attention.

As was explained in the Groundwater Basin section, our estimate of the average annual overdraft in the Orcutt sub-unit is 18,570 acre feet. Table VIII on the next page shows the proportionate share of overdraft for the three major pumpers in the sub-unit.

Table VIII
ORCUTT SUB-UNIT PUMPAGE AND PROPORTIONATE
SHARE OF OVERDRAFT (18,570 AF) IN 1989

	Consumptive Use (AF)	Percent of Pumpage	Share of Overdraft (AF)
Agric.	7,000 (est.)	25	4,642
SM	12,471	44	8,171
Cal Cit	8,769	31	5,757
Total	28,240	100	18,570

Again it can be seen that, if the City is successful in procuring State Water, it will clearly eliminate its share of the sub-unit overdraft (at current pumpage rates). Cal Cities, with a current State Water Project entitlement of 3,000 acre feet, would be short of its share. To the degree that the City can encourage Cal Cities to increase its entitlement of State Water, the overdraft problem will be decreased. These values for urban users will only increase in the future and thus the overdraft amounts shown above are actually optimistic ones, representing as they do current and not future use.

Agriculture can only reduce its use of basin water by reducing acreage, planting crops using less water (usually of lesser value) or by more efficient use of water. Reducing acreage or changing crop patterns to save water could have a substantial economic impact on agriculture and the economy of the valley. Decreased efficiency could also result.

Water is a major cost to agriculture. There is strong incentive to reduce water use in the future. The draft Coastal Branch EIR estimates that agricultural water use will decline by about 10,000 acre feet by the year 2000. If this should occur (which we doubt, although there could be substantial reductions), and if urban purveyors obtain their current allotment of State Water, the overdraft would be reduced in the following proportions in the year 2000:

TABLE IX
PROPORTIONATE REDUCTION IN THE YEAR 2000
IN OVERDRAFT THROUGH AGRICULTURAL CONSERVATION
AND CURRENT STATE WATER ALLOTMENTS

	Share of Reduction (AF)	Percentage
Agriculture	10,000	40.7
City of Santa Maria	11,300	45.9
Cal Cities	3,000	12.2
Guadalupe	300	1.2
Total Reduction	24,600	100.0

If each urban purveyor increased its State Water allotment to support its needs at the time of completion of a coastal aqueduct in 1997-1998, the overdraft would be reduced in the following proportions:

TABLE X
PROPORTIONATE REDUCTION IN THE YEAR 2000
OF OVERDRAFT THROUGH AGRICULTURAL CONSERVATION
AND INCREASED STATE WATER ALLOTMENTS

	Share of Reduction (AF)	Percentage
Agriculture	10,000	23.7
City of Santa Maria	19,000	45.0
Cal Cities	12,000	28.4
Guadalupe	1,200	2.9
Total Reduction	42,200	100.0

The overdraft would increase with the estimated additional urban use in 1998 to about 37,000 acre feet. This amount could be less if the per capita use of water is reduced through conservation or there is less urban growth than in the immediate past. Agricultural use is assumed to remain constant. It therefore appears that the overdraft could be eliminated by 1998 if urban users then used State Water as their source of supply.

We also investigated conjunctive use of the Orcutt sub-basin. This would involve purchasing additional State Water and injecting it in the Orcutt sub-basin for future use.

However, this plan is not feasible. Water injected in the sub-basin would be used by Cal Cities and agriculture. State Water will be treated before it is delivered to the Santa Maria terminus at a cost of about $110 per acre foot. The high quality State Water would be mixed with low quality ground water and thus its quality advantages would be lost.

However, purchase of additional State Water for future use beyond 1998 is feasible if acceptable financing can be developed and actual delivery of the water delayed. The allotment costs must be paid each year, regardless of whether water is delivered. The cost of delivery, such as power, and the cost of treatment would not be payable if water is not actually delivered. Therefore, additional allotments could be obtained and held until the water is needed in the future.

Assuming that an average residence uses one-half of an acre foot of water per year, the cost of holding additional State Water allotments for future use would be about $210 per year per residential unit. If additional allotments were obtained to serve estimated growth for five years, the total allotment cost per residence would be $1,050 plus interest costs. The City could thus obtain State Water for future use at a cost of about $1,200 per residential unit, to be paid when the unit is built.

This would increase the cost of future housing. Current water users would not subsidize such future growth.

To summarize, we conclude that the use of State Water as the principal supply of urban users can eliminate the overdraft by 1998. State Water will eliminate the cost to the City of cleaning up ground water and sewer discharge for many years so that, in the long run, consumers will pay less for water and sewer services. It is likely that the same result will occur in the Cal Cities service area if State Water is used to serve the Orcutt area.

C. Consequences of No Action

Next, we move to address the question of the consequences of not taking steps to reduce the overdraft of the Santa Maria Valley groundwater basin.

Continued overdraft will ultimately result in water shortages. The shortages can only be eliminated by reduction in use of water or by development of supplemental water supplies. If supplemental water is not developed, then the shortages will be apportioned, either by attrition of agricultural use or by legal measures.

Shortages can be apportioned legally by adjudication or by governmental control of the groundwater basin. Adjudication involves a determination of the amount of water that can be used by each landowner or water purveyor taking water from the basin. Each landowner is entitled to the amount of water that can be extracted from and beneficially used on his parcel of land. Each landowner's right is subject to the correlative rights of all other landowners in the basin. When the water in storage is insufficient to satisfy the rights of all landowners, the shortages are apportioned by court order or regulatory edict among all landowners and users.

Public utilities and municipal water purveyors have the right of eminent domain. These users can condemn water for municipal and industrial use. Thus, agriculture cannot be assured of adequate amounts of water as against municipal and industrial users.

Historically, adjudication proceedings have not been used unless there is supplemental water available from other sources. Adjudication, historically, has resulted in municipal users of water obtaining supplemental supplies.

Therefore it is likely that, if the overdraft is not reduced or eliminated, the City of Santa Maria will eventually have to compete with other water users in the valley. If agriculture does not reduce its use of water due to increased costs or unsuitability of the water supply, then it is likely that adjudication proceedings or governmental basin management will result. These proceedings are extremely complicated, lengthy and expensive. It is not possible to predict the outcome of adjudication

proceedings or basin management. However, it is likely that the end result will be that the City will have to condemn water supplies for municipal and industrial use or develop supplemental sources. Either course of action will be expensive.

V. WATER QUALITY

A. Introduction

The most serious problem facing users of the Santa Maria Valley groundwater basin is that of poor water quality. This section of the report reviews the dimensions and causes of this quality problem.

A number of factors enter into the poor water quality equation, not the least of which is the geological make-up of the watershed. Rich in sedimentary rock and deep alluvial fills containing soluble minerals, runoff and percolated waters dissolve and carry off these minerals. The actual parts per million of total dissolved solids in valley groundwater has always been relatively high. Historically, better quality water has been found in the southern and eastern portions of the basin and thus these areas have been heavily pumped by municipal and industrial users.

The City of Santa Maria, beginning in the early 1960s, drilled a number of new wells in order to tap higher quality water. Prior to this time, the City relied on a relatively few wells whose total dissolved solids levels were getting close to the 1,000 parts per million level which would have required demineralization in order to remain potable. The new wells allowed the City to lower its weighted average total dissolved solids in 1986 to 772 parts per million. As of December 18, 1990, beginning a fifth year of drought and with City well levels at an all time low, the total dissolved solids levels have exceeded 800 parts per million.

In the area of wastewater discharge quality, the City is also facing a major problem. Currently it is out of compliance with Regional Water Quality Control Board discharge requirements for total dissolved solids, sodium, and chloride. The Laguna Sanitation District, which serves the Orcutt area, is currently under a RWQCB order to limit discharge until the quality of effluent is improved.

Looking at the basin as a whole, the continued use of large quantities of water for agricultural irrigation will exacerbate the deterioration of water quality as ever greater proportions of solutes are concentrated in irrigation return water. In addition, agricultural chemicals contribute to water quality problems. These areas are examined in more detail below.

B. Water Quality Threats to the Basin

The Santa Maria groundwater basin is vulnerable to various sources of contamination including municipal, industrial, and agricultural. Compared to other basins in California, we are fortunate to have not experienced any widespread or serious incidents. In the past decade a number of new government programs have been instituted to monitor and protect the basin, most of

them administered by the Regional Water Quality Control Board. This section of the report reviews the major sources of threats, and the programs in place to protect and correct problems.

Municipal and Industrial Threats.

Landfills. A number of private and public abandoned or operating landfills are located in the basin. Prior to the 1980s there was very little control or concern as to what went into these dumps. Potential sources of groundwater contamination exist from rainwater percolation through the waste carrying contaminants down into the aquifer or from groundwater actually encountering the waste. So far there is no evidence that any serious contamination has taken place.

The City of Santa Maria's landfill is the largest in the valley, covering 160 acres and receiving over 500 tons of waste per day. The City currently has in place a mandated program for monitoring groundwater quality (Solid Waste Assessment Test Water Quality Assessment) and eight monitoring wells. Recent analysis of water samples (April, 1990) show trace amounts of below action levels of various organic compounds (acetone and carbon disulfide). Because of the permeable nature of the soils above and below the dump site, there is a clear potential for leachate generation and it is probable that wastes have had some effect on water quality. Landfill employees currently screen the deposit of hazardous waste through questioning landfill users, random inspections of loads, and visual inspection of disposed waste. It is probable that significant amounts of hazardous waste find their way into the landfill despite these efforts.

The City continues to participate in a voluntary and free household hazardous waste collection program which increases the likelihood such wastes are disposed of properly. In addition, the City is seeking to develop a fully permitted household toxics disposal and containment facility at the landfill--for items such as used motor oil, batteries, paint, anti-freeze, solvents, cleaners, pesticides, etc. In addition, the City is currently seeking to contract for curbside recycling which would include the pickup of used motor oil. These programs and their associated expenditures are very cost effective when compared to the expense of cleaning up contaminated groundwater.

The Casmalia toxic waste landfill is located two and a half miles from the southern boundary of the basin and is one of two existing Class I landfills in California. In existence since the early 1970s, and prior to EPA siting criteria, the dump contains thousands of tons of extremely hazardous waste in unlined pits. Serious contamination of groundwater beneath the site currently exists, and some migration offsite has also occurred. The prevailing consensus of government and private experts is that this migration is unlikely to reach the basin in less than 10,000 years.

Wastewater Treatment Plants. A number of wastewater treatment plants discharge treated effluent into the basin including

the Laguna Sanitation District, City of Santa Maria, City of Guadalupe, and numerous private operations. The City of Santa Maria, operating under federal and state mandates, issues discharge permits to business and industrial users and monitors the quality of wastewater. The City provides an annual report to the Environmental Protection Agency, State Water Resources Control Board, and RWQCB. All such dischargers are permitted and regulated by the RWQCB, which maintains standards for treated effluent.

Both the Laguna Sanitation District and City of Santa Maria are currently in non-compliance for the amount of allowable total dissolved solids, sodium, and chloride in the effluent of their wastewater treatment plants. It is estimated that 50-60 percent of the levels of these three constituents (above those present in delivered water levels) are attributable to the use of private water softeners.

There are two approaches to improving the quality of treated effluent at the wastewater treatment plant. One is to improve the quality of water supplied to homes such that water softening is no longer necessary. A second approach is to "capture" low quality effluent and not allow it into the wastewater stream--or at least into the groundwater. The City is currently pursuing both of these options as short and long-term mitigations to the wastewater contamination threat.

With the support of the RWQCB, the City is acting to acquire the rights and/or permits necessary for deep underground injection of salt brines. The plan is to use abandoned or existing oil field brine injection wells for the disposal of municipal sources of salt brines which currently go to the treatment plant. Such a plan would entail the concentration of various point sources of salt brine discharge, the largest affected group being residential water softener users. In order to manage the thousands of point sources of salt brine, it will be necessary for residential water softeners to be of the canister type which are collected and serviced by private businesses. These businesses will then be responsible for collecting and transporting the brine to the injection well site. Such an operation will require new ordinances and requirements on the part of the City.

A second option also being pursued by the City is the development of a high quality supplemental source of water--the State Water Project. With an average total dissolved solids of 220 parts per million, the State Water Project would provide the City with a source of water which, if delivered in appropriate proportions with blended groundwater, would allow reduced softening. It is important to remember that current State Water Project entitlements could not fully supply the City's current needs and would fall significantly short of meeting demand in 1997 or 1998, when deliveries may begin. Thus, State Water Project water will be blended with poor (and deteriorating) quality groundwater which will lessen its positive impact on wastewater mineral load. If the City could increase its entitlement to the amount sufficient to supply its estimated needs at time of delivery, it would be

better able to provide quality water to its customers and reduce the minerals entering the treatment plant.

The Laguna Sanitation District is also in non-compliance with the RWQCB and is also looking into the salt brine injection well as a partial solution to their problem. Currently the California Cities Water Company has entitlement to 3,000 acre feet of State Water Project water. This amount would not be sufficient to greatly improve water quality entering the Laguna treatment plant. It is our opinion that both the best and cheapest solution to the problem would be for Cal Cities to increase its entitlement to a level sufficient to meet its current water demand.

Leaking Underground Fuel Tanks (LUFT). In January of 1990 a new program, supervised by RWQCB, was instituted to clean up leaking underground fuel tanks, most commonly at gas stations. The county has responsibility for testing and monitoring underground tanks, and the LUFT program assesses and remediates all leaks and bills the responsible parties. There are currently 40-50 LUFT sites in the Santa Maria-Orcutt area, none of which have resulted in groundwater contamination. Two sites at the airport have resulted in contamination of a perched water table with eight different chlorinated solvents and the closing down of one City well. There are 12 sites in the Guadalupe area, two of which have contaminated shallow groundwater with gasoline. This program, which sunsets in another three years, appears to be successful in identifying and remediating leaking underground tanks.

Agricultural Threats. Agriculture is the largest industry in the basin, accounting for 80 percent of water consumption. Agricultural chemicals pose a threat to the groundwater basin. For example, many tons of fertilizers are applied to fields each year including urea, liquid ammonia, ammonium nitrate, ammonium sulfate, sodium nitrate, anhydrous ammonia, and manures. Although much of the fertilizer is consumed by crops, a certain portion finds its way back into the groundwater. This is clearly evident by the fact that large numbers of wells (including two of the City's) exceed EPA levels for nitrates. Besides the threat they pose to public health, especially for children, such fertilizers add a significant amount of new salts to the basin each year (Hughes, 1977).

The actual process of crop irrigation is one which further degrades water quality. As water is pumped onto the fields, approximately 75 percent of it is consumed by the crops or evaporated. Any minerals in the water are thus concentrated in the remaining 25 percent which percolates back into the basin more saline than when it was first pumped to the surface. Hughes (1977) estimates that over 135,000 tons of solutes are concentrated in the basin each year from irrigation, compared to 13,000 tons from municipal and industrial sources.

This degraded water quality becomes a vicious cycle for agriculture. Salts build up in the upper soil levels which reduce crop yields. These salts have to be flushed out by the application of

even greater quantities of water, which further decreases quality, and so on. The only mitigation for irrigation degradation of groundwater is greater efficiency of application. The less water that is applied, the slower the rate of degradation.

Pesticides and herbicides constitute another threat to the groundwater, and we are not able to fully assess the threat or danger to the basin from this source. It is known that other groundwater basins, for example in the San Joaquin Valley, have been seriously contaminated with agricultural pesticides (especially nematocides). While previous well samplings and studies have indicated no serious cases of contamination in this basin, recent studies by the County Health Department have shown traces of fungicides in some wells. It is important that the county continue its testing program of basin water quality. The City is required to conduct periodic tests of water quality in its wells.

Salt Water Intrusion Threats. The United States Geological Survey (see Appendix A) maintains two wells for the purpose of monitoring the intrusion of sea water into the basin. These wells, Guadalupe No. 1 (10N36W2Q1) and Guadalupe No. 2 (11N36W35J2), are sampled once a year. Reports on water quality from these wells are forwarded to the County Water Agency.

C. Annual Water Division Report. This report, prepared by the Public Works Department, includes sections on water production, distribution, and quality. It provides the logical place for annual compilation of water quality information of which the City Council should be aware. While the current report is clear and contains important information, such as a historical chart showing yearly changes in average total dissolved solids levels, other types of information on water quality could also be included. This would serve to compile such relevant information in one place.

VI. WATER CONSERVATION

A. Introduction

The Santa Maria City Council, on August 7, 1990, considered and implemented a voluntary water conservation plan with a goal of 10 percent reduction. The committee feels that an additional 10 percent can be achieved through other measures such as installation of water saving fixtures, irrigation hardware, review of rate structures, retrofitting of existing homes, and development of additional educational programs. The focus of the plan is on education and increasing public awareness while at the same time addressing both supply and demand management. Supply management is designed to improve efficiency and reduce waste within the production and delivery systems. Because it can reduce water loss and waste without depending on water users, it is generally preferable to demand management. Examples include leak detection and meter calibration and repair programs. Also included is a demand management component which focuses on the user conserving within the home or business.

The Urban Water Management Planning Act adopted by the State Legislature in 1983 required water purveyors to adopt an urban water management plan on or before December 31, 1985. The law required that the plan include the various elements of supply, demand, conservation, and alternative conservation measures. The City, on June 7, 1988, approved a plan prepared by John Carollo Engineers dated December 1987. The Act requires that each urban water supplier, such as the City, review its plan at least every five years.

This chapter does not purport to cover in detail all of the elements required by the Act. It is hoped that this chapter could provide the basis for updating the City's Urban Water Management Plan.

B. City Conservation Plan

The Water Conservation Plan is composed of two components: 1) Public Information and Education, and 2) Water Audit Program.

Public Information and Education. Public information and education can be thought of as the backbone of any good water management program and can typically result in a five percent water savings. An even higher percentage can be found if the public's perceived "need-to-conserve" is high.

The City Public Information Officer plays an integral role in this portion of the City Water Conservation Plan. News releases, public service announcements, and press conferences are used to explain the program and goals to local news media. Informative seminars, articles in the city-wide newsletter "In Touch," direct mailings, and developing programs for the local schools have constituted the core of the voluntary program.

The water bill has been modified to include water use for the prior year's billing period so as to provide a comparison with the current billing period for the customers trying to monitor their water conservation efforts. In addition, brief water savings hints have been added to the water bill to remind customers of the need to conserve.

A self-guided xeriscape demonstration garden is available to the public which offers a variety of plant materials suitable for use in our area and which are suggested for planting in the Planning Department's "Landscape Guidelines." The largest single use of urban water supplies in California is for irrigating the landscaped areas around homes and apartments. Statewide, 47 percent of an average household's water is used outdoors. Studies have shown that turf is generally watered twice as much as is required. Just by watering the landscape more efficiently, the average customer could cut water use by 25 percent. Converting from a traditional landscape to a water-conserving one generally results in an approximate 54 percent reduction in the overall amount of water used for landscape irrigation. Based on the City's 10-year average of 192 gallons per capita per day, just a 25 percent reduction from more efficient watering would result in a savings of 48 gallons per capita for single family homes. This translates into an average annual savings of 1,800 AFY or 15 percent of total water consumed in the city this past year.

Other agencies such as the Chamber of Commerce and the Economic Development Association are evaluating their degree of assistance in the City's program. The Water Conservation Coordinator has worked individually with a group of commercial water users with high consumption rates in an effort to help them manage their water use more efficiently. Many of the commercial users have invested in more efficient equipment or are utilizing some type of conservation measure in order to reduce their costs. This program will continue as an on-going part of the water awareness portion of the water conservation plan.

Due to the nature of the public information program, it is not possible to estimate a specific water savings as a result of implementation of the City's conservation measures described above. However, implementation of the water-saving measures advocated through the program do save water. It is reasonable to assume, therefore, the measures outlined above have played a role in increasing attention to water conservation evident in Santa Maria.

Water Audit. The water audit portion is composed of a water conservation kit give-away; a meter calibration, maintenance, and repair program; and a "notice of high water use" program.

The water conservation kit program is free of charge to city residents. The kit is composed of a flow restrictor for the showerhead which reduces flow from approximately five gallons per minute to three gallons per minute, a toilet tank water displacement bag which saves 0.7 gallons per flush, and dye tablets for the toilet tank to help detect leaks. The benefit of the dye tablets is that many toilets leak and this is a quick, simple,

and effective method of checking for leaks. If a leak is found, it usually can be corrected by a simple adjustment or by replacing several relatively inexpensive parts. The program targeted one-third of the City's residential water accounts as a goal for installation of the kits. A water reduction of five to nine percent for interior water use (seven to 13 gallons per capita), for a potential annual savings of 28 - 53 million gallons (87 - 163 acre feet per year) can be expected. The relative dollar savings for the above program could amount to $22,000 - $43,000 city wide. Table XI provides details on the costs of installation, water saved, and cost/AF for several conservation measures.

TABLE XI
SAVINGS DERIVED FROM CONSERVATION MEASURES

Measure	Cost Per Installation	Water Saved-AF/Y	Cost/AF
Toilet Retrofit	$163	1,320	$250
Water Audits	$35 - $50	790	$290
Conservation Kits*	$0.63	87	$267

*Based on dwelling unit density of 2.894 persons/dwelling unit

Another effective program the City offers free to city residents is notification of higher than normal water use. A computerized billing system notes higher than normal water use and "flags" the account. Customers are contacted and offered a service call to try to find the cause of the high water use. If interested, an appointment is made, and the customer agrees to pay for any repairs or expenses incurred.

The Water Division of the Public Works Department has in place a program to calibrate, repair, and replace water meters. The meters slow down due to wear and become inefficient. All meters are replaced every 10 years. Large (6") meters are tested and repaired if needed on a yearly basis, and 4" meters are tested and repaired if needed every two years. A program such as this tries to reduce unaccounted for water loss, which in turn reduces water production costs and increases revenues from water sales.

It should be noted that, based upon the experience of other jurisdictions that have implemented water conservation programs, a potential loss of water revenues results. Evaluation of the water conservation program will be done through an annual report which documents the past year's water conservation effort. This will include water usage, annual per capita consumption, and the results of the various conservation programs. The annual report will also contain the proposed major program emphasis on activities for the upcoming year.

C. Water Rates and Pricing

Traditionally, water pricing has been used as a means to recover costs by charging various categories of users in accordance with

the cost of serving that type of user. This approach was perceived to be both effective and equitable.

More recently, pricing has taken on an additional role, that of demand management. This has come about because of drought-related shortages and because of the dramatic increase in the cost of developing additional water supplies to meet growing service area populations. In either case, measures that reduce demand have become more acceptable in light of the difficulty and high cost of adding to supply. Pricing can work to reduce demand by providing an incentive for customers to manage water use more carefully.

The key to this approach is the link between the customer's water bill and the amount of water used. Actions that enhance this link are important to using pricing as a demand management tool. Maximizing the portion of the bill that varies with water use by shifting as much as possible from fixed water charges or ad valorem taxes serves this purpose. Public awareness programs to show customers how to reduce water costs by conservation are also critical to the success of this approach.

The customer's sensitivity to pricing is also enhanced by rate structures that increase the cost of water at a constant or increasing rate as use increases. The typical arrangement to provide these structures is a uniform or an increasing block rate with a small fixed or minimum charge. The increasing block rate will usually provide a greater incentive to conserve.

The City of Santa Maria currently has a Uniform Block Rate pricing structure with a minimum charge of $6.40 for the first 300 cubic feet (3 billing units). Cost per each billing unit thereafter is $0.61 with a provision for an annual five percent increase each September for inflation and expenses. An additional 5.5 percent increase is factored in each January to contribute to a sinking fund to finance infrastructure required to implement delivery of supplemental water. The current pricing structure for the City could be modified to encourage conservation or reduction of water demand.

The preparation of the upcoming Urban Water Management Plan requires implementation of "Best Management Practices." This could include rate structures and other economic incentives and disincentives to encourage water conservation, possibly including seasonal rates, increasing block rates, and minimized service charges; charging new connections with a sliding scale connection fee targeted to encourage installation of water-efficient fixtures, appliances, and landscapes; and developing a grant or loan program to help finance conservation projects by residential, commercial, and industrial customers.

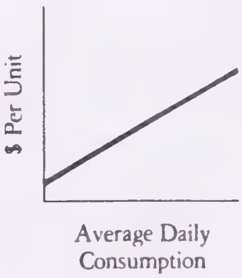
In calculating a new rate structure, the differential between current and future cost for delivered water needs to be kept in mind as well as the fact that any demand reduction will result in diminished revenues from water sales. The City should pursue a pricing policy which will result in long-term average reduction

of consumption through the application of increasing block, sliding scale and/or lifeline structures. These structures are explained in greater detail below.

PRICING STRUCTURE

a) Increasing Block. Price per block increases as consumption increases. Best used for reducing average and sometimes peak use. Large volume users may consider inequitable.

b) Sliding Scale. Price level per unit for all water used increases based on average daily consumption. Best used for reducing average and sometimes peak use. Large volume users may consider inequitable.



c) Lifeline Pricing. Price for "necessary" water use kept low. Best used for reducing average use. Usually used to insure that low income users not unduly burdened by high prices.

D. <u>Alternative Water Conservation Measures</u>

This section presents measures which could be implemented by the City of Santa Maria to promote community-wide water conservation in an overall effort to reduce water consumption.

Water Audit Program. The water audit program focuses on supply management by surveying the water system and demand management by helping customers check for leaks, use water more efficiently, and install conservation hardware. This section is much more comprehensive than the program the City now offers.

Residential Water Audit. Residential water audits, also called home water surveys, are programs whereby trained auditors are hired to go to homes on an appointment basis to conduct an interior and exterior home survey which includes:

* Install high-efficiency showerheads, toilet dams or displacement devices, faucet aerators, and other water conservation materials as deemed feasible and cost effective.

* Check toilets for leaks and make simple adjustments if applicable.

* Check for any water leaks on the property and assess the volume of waste.

* Inspect and test the home lawn irrigation system.

* Determine a custom irrigation schedule for the resident's lawn (see Exterior Home Survey).

* Make all applicable recommendations concerning ways the resident can make improvements and how best to accomplish those necessary tasks.

Who conducts the home water surveys? Depending on the resources available, the City could draw on "master gardeners," local job training programs, college students, staff on hand, or contract with consulting firms to manage the program. In all cases, a program manager must be responsible for setting up the program, advertising it, training the auditors, scheduling the audits, and analyzing the data. Benefits of a program of this nature include saving water, reducing peak demand, improving relations with residential customers, and compiling valuable water use data. The cost of an audit ranges from $35 to $50 per account. Anticipated savings as reported in a study from 1988 are 27 percent of outside water use and about 18 percent of total annual water use. Documentation of actual water savings is limited.

Exterior Home Survey. The exterior home survey consists of inspecting the property for leaks, surveying the irrigation system, investigating irrigation practices, and observing other water uses around the home. The emphasis is placed on lawn irrigation practices since this accounts for the most significant water consumption at the home. All recommendations are presented to the resident along with proper instructions. The auditor performs the following procedures:

* Soil analysis - Take a core sampling of the turf soil to determine the absorption rate, soil compaction, water retention capability, moisture depth, root zone depth, and thatch build up.

* Irrigation system check-up - Run each station of in-ground systems to check for proper coverage, mismatched heads, broken heads, misdirected heads, and unnecessary overlap of stations.

* Precipitation test - Measure the precipitation rate of the sprinkler system for the lawn and determine the output in inches per hour.

* Calculate the preferred run time and frequency for the watering of the turf, based on the results from above.

* Check for and determine the volume of water leaks at exterior faucets.

* Recommend drip irrigation systems for non-turf vegetation, if applicable.

* Recommend other water saving measures, such as pool covers, if applicable.

System Water Audits. Water audits examine water records and system control equipment to determine how efficiently the delivery systems are working. Studies for the California Department of Water Resources and the State Water Resources Control Board have shown 9.5 percent of the water flowing through California's municipal systems is unaccounted for. Some of this is from metering errors and authorized use, such as firefighting and flushing water mains; but about four percent is estimated to be wasted through leakage. According to the study, leak detection and repair could save a substantial amount of water that would otherwise be wasted. In the case of Santa Maria, the four percent figure amounts to approximately 500 AFY or $132,335 in potential revenues if the estimates are correct.

Additional benefits of conducting system water audits are reduced water losses and power costs, better knowledge of the overall system, more efficient use of existing supplies, increased revenues, and improved public relations. Costs are variable depending on how extensive the program is - currently the City Water Division employs a full-time person for meter repair, calibration, and replacement.

Efficiency of a water system is normally measured by the percentage of unaccounted-for-water (water loss). The water system loss is simply the difference between the amount of water produced and amount of water sold to the customer. Unaccounted-for water can be categorized into four distinct groups, the last three of which can be assessed by a thorough system audit:

* Authorized unmetered water use

* Unauthorized unmetered water use

* System leakage

* Meter inaccuracy and accounting errors

Leak detection surveys use sonic leak detection equipment to discover and pinpoint the exact location of leaks. Benefits of detecting and repairing leaks include water saved, and money saved for the value of the water, water treatment, and pumping and distribution costs. Costs of such a program are variable, but an average cost reported by DWR is $200 per mile. Given that Santa Maria has over 200 miles of water lines, the cost could reach $40,000 for the entire system.

DWR maintains a Water Audit and Leak Detection Program providing water audit and leak detection technical assistance to water agencies with over 100 connections delivering potable water in pressurized systems. They also offer services to train local water agencies to conduct water audits on their own systems; teach how to plan leak detection surveys; teach how to use leak detection equipment to discover and pinpoint the location of leaks; and loan leak detection equipment for a specified length of time. Currently, the City Water Production Supervisor has been trained to perform leak detection surveys.

City Well Startup. Each City water well at the Santa Maria Airport produces a loss of water upon startup for the important purpose of reducing input of sand into the City's water mains.

The typical well produces about 2,000 gallons per minute, and this is discharged for about five minutes. An automatic valve gradually stops the flow to waste and forces the stream of water into the pressured City system (about 100 PSI). It is estimated that this wasted flow would average 1,000 gallons per minute for five minutes or about 5,000 gallons wasted per startup. If the above wells started on average once per day, then 5,000 gallons X 8 wells X 365 days = 14,600,000 gallons per year or 45 acre feet per year which could be saved.

One solution could be a five to ten thousand gallon tank installed at each well to receive such startup water. A small secondary pump (10-20 gallons per minute) could then pump that tanked water back into the system for normal use, thus saving the wasted water. It is estimated that this system could be installed at each well for $5,000 capital cost and operated for an annual cost of $1,000 per well. If so, the saved water would cost:

Annual Cost O&M	=	$1,000
Capital Cost	=	500
Total	=	$1,500

The water saved per well:

5,000 (365) = 1,825,000 gallons or 5.67 AFY

$$\frac{\$1{,}500}{5.67 \text{ AFY}} = \$265 \text{ per acre foot which appears very cost effective.}$$

Home Reverse Osmosis Units. Many residences in the valley have chosen to utilize home reverse osmosis (R.O.) units to purify a small quantity of water for drinking, cooking, etc. as an alternative to buying bottled water. These units typically produce 2.5 to 5 gallons per day of improved water.

It is a little known fact that these units typically waste five to ten times the amount of water produced. The filtered water passes through the membrane, and rejected water which contains the salts removed from the filtrate is discharged silently down

the drain. If an average household uses five gallons per day, the unit may be discharging 25 - 50 gallons per day into the sewer system. This water is higher in TDS and increases both water pumped for domestic service and that amount which must be treated at the waste water treatment plant. If 5,000 units are operational within the City (1/3 of homes), then the water so consumed could amount to millions of gallons per year (138 - 276 AFY).

There is at least one R.O. unit available which does not discharge any water to waste but instead distributes it to the remainder of the household uses. Since there is a wide range of efficiency, it seems prudent to limit the usage of R.O. units which at least meet the standard of 5:1 rejection as a maximum. Also, many units have automatic shut-off to waste when the water tank is full. This should also be a minimum requirement of approved units.

E. Mandatory Water Conservation and Water Rationing Options

The committee is not suggesting that mandatory water conservation or water rationing options be implemented at this time. However, these options have been included for informational purposes for use by the Council at a future date should circumstances warrant. The goal of the Mandatory Water Conservation and Water Rationing program would be a 20 - 30 percent reduction in water use. The following elements could be included in the program:

* Ordinances. These could include making water waste illegal, controlling outdoor watering, and restricting non-irrigation outdoor water uses.

* Rationing could be accomplished through fixed allotments or percentage cutbacks. Fixed allotments such as a lifeline allowance with charges for excessive use or percentage cutbacks with a specified goal and penalties for overuse have been utilized in other communities.

* Penalties such as placing flow restrictors on the water meter or shutting off the water in extreme cases are examples. Very high water rates for water consumption above and beyond a set limit are effective deterrents to high water use.

* A continuing public information campaign is critical to the success of the program. It is aimed at keeping the public fully informed and avoiding confusion.

* Restrictions on new construction may have to be considered.

F. Past Conservation Measures

The City of Santa Maria has been practicing water conservation over the long term which includes wastewater reclamation, storm water retention/recharge, a City-developed low-water-use demonstration garden, landscape guidelines for multiple family dwellings and mitigation measures for new developments, a state-of-the art computerized irrigation system in a majority of the City parks and public facilities, and a customer water audit/leak detection program. The results of these efforts are several million gallons of water per day being conserved or recharged into the groundwater basin.

The City of Santa Maria, as the largest water user in the city, has an obligation and a responsibility to use water efficiently and set an example for others to follow. In this spirit, the City has embarked upon a multi-faceted effort to improve conservation efforts within the city. An example of past practices includes the Wastewater Treatment Plant, which reclaims treated effluent to irrigate 40 acres of permanent pasture which is grazed by sheep. It is also used to irrigate a neighboring Christmas tree farm, and the remaining water is directed into percolation ponds where several million gallons per day are recharged back into the groundwater basin. This feature was part of the plant's original design. Another conservation measure is the capture of storm runoff.

Retention/Recharge Basins. The City of Santa Maria and the Santa Maria Valley in general have participated for many years in reclaiming rainfall runoff which otherwise would be lost to the ocean by way of the Santa Maria River.

Early Santa Maria developed without an underground drainage system. As the city grew in size, increasing this runoff from the previous development, flooding problems emerged during rainstorms. Prompted by this problem, and aided by the County Flood Control Agency, a system of pipes and intervening retention basins was created. A good example is the development of Simas Park Basin in the 1978-1979 time frame. The storm water retardation aspects of this park saved enough money by reducing peak runoff flows (hence pipe size) in downstream piping to completely construct the new park facilities. The secondary benefit to this was the recharge of the groundwater under the park and hence the groundwater basin. This park and similar systems at Adam Park inspired a policy which had both flood control and groundwater benefits.

All projects within the City and North County are now required to provide on-site retardation. This is achieved by setting aside an area, usually in landscaping, which retains water during peak rainfall and meters it into the flood control system at a rate similar to normal runoff of undeveloped land. As noted before, the by-product of this system is added groundwater recharge during the detention time providing the basin soil is pervious.

The City encourages that these basins be regionalized where practical for improved maintenance, aesthetics, and long term control.

Under normal rainfall conditions, which are generally light amounts, the rainfall runoff will percolate into the basin through these retention ponds. As the flows increase, the water moves westerly through several main collector systems. These collector systems are as follows:

* The Simas Park/Adam Park/La Brea Basin System.

* The Downtown/Church Street/West Main System which flows to the Santa Maria River near Bonita School.

* The Northwest System which drains westerly to the Blosser Channel, then northerly to the Preisker Basin southwesterly of Preisker Park.

* The Bradley Channel System which collects all farm and residential waters east of the freeway into a pond just east of U. S. 101 and north of Donovan Road. It then travels northwesterly to the Preisker Basin and thence to the riverbed.

* The Orcutt Recharge System: Almost all of the area south of Betteravia Road (the south escarpment of the Santa Maria River) is overlaid with impervious soil known as the Orcutt Formation. Since this water essentially was all lost by going west to Betteravia, a unique system for its recapture was built by the County Flood Control and Water Agency aided by clean water grant funds.

  The Orcutt runoff is collected in a series of basins and pipes (i.e., Lakeview/Airport Skyway Channel - Foxenwoods Basins - Solomon Creek/Blosser Road) and directed into a holding basin just northerly of the Green Canyon Channel on airport property at "A" Street. From that holding basin it travels 1-1/2 miles in a pipe north to the 22-acre Getty Recharge Basin. This system is estimated to be capable of generating up to 2,000 AFY of high quality recharge during wet years.

Since these basins receive water which is very low in TDS (usually under 100 ppm), their recharge to the groundwater basin is more beneficial than volume alone. The groundwater depression in Orcutt can be enhanced by this quality water which tends to form a mound of higher quality/lower TDS water under the basin.

Thus the basins which are situated between the primary water supply source (Santa Maria River) and the area where the municipal wells are located (Airport/Orcutt) provide for improved water quality. Those basins will dilute water migrating from the river to the pumping depression, providing better quality TDS water. The westerly basins will protect from back siphoning the poorer quality western valley water into the drinking water pool.

Unfortunately, there is precious little rainwater available except in a very wet year. During those times, the system will trap, hold, and recharge substantial amounts to improve our quality.

City Leak Detection Program. Other measures the City has been involved in include providing the fundamentals of a leak detection/water audit program. This basic service is performed to assist customers in identifying leaks and areas of high water use which could be reduced. Any costs involved in the program are borne by the customer, and generally leaks are attributable to the toilet and are easily repaired for a substantial savings in water.

Landscape Guidelines. Another example of past efforts toward water conservation includes the development of landscaping policies and guidelines. Chapter 44 of the City's Zoning Regulations, titled "Uniform Landscape Guidelines," was adopted to prescribe policies and regulations for landscape development that would provide for the creation of a water conserving, functional, and aesthetic outdoor environment. To support this effort, the City also developed and made available to the public a Landscape Development Guidebook which discusses the City's program for installing drought tolerant plants, shrubs, turf, and trees. A City of Santa Maria Plant List has been developed and made available which provides the names of low water-use shrubs and ground covers suitable to the area. A self-guided xeriscape demonstration garden is open to the public which displays a variety of plant material suitable for planting in our area. The garden is located at the northeast corner of Broadway and Main streets.

Recreation and Parks Department. The Recreation and Parks Department is also conscientious about water conservation. Beginning with the 1986-88 fiscal budget, the Department initiated a program to improve the irrigation efficiency of the City's landscaped areas. In recent years, technological improvements have been made in the design and materials of landscape irrigation systems. It is recognized that a properly designed and efficient sprinkler system is the best method to achieve and maintain a good water conservation program. In 1986, the Department began to upgrade the irrigation systems in the City's parks by replacing old antiquated lines, heads, valves, and controls. Concurrently with this effort, in late 1988 a state-of-the-art computerized system was acquired which has dramatically improved the irrigation efficiency at each site where it is in place. A reduction in water use of 35 percent has been the general average.

The following is a summary of water conservation efforts undertaken by the Department:

* Program to upgrade park irrigation systems. Of the 14 sites needing improvement, six have received all or some amount of upgrading.

* Computerized irrigation system. A computerized system to control the amount of water applied to each site is being phased in as part of the City's budget process. At the present time, ten park sites are computerized, leaving seven sites plus the street landscaping (medians, easements) yet to be completed. All new park construction will have the computer system such as the recently opened Hagerman Softball Center and residential neighborhood sites like Sunrise Hills and Rancho Verde Park.

* Median Redesign. When the south Miller Street landscaping program started some eight years ago, a new median design standard was established that reduced the planting area by 45 percent. A decorative stamped concrete (Bomanite) is now required on all medians as an effort to reduce the water and maintenance costs. Another new feature is to provide a strip of Bomanite 10" to 12" wide along the inside of the median curb which slopes toward the center of the median, helping to retain water within the median. The Engineering Division of the Public Works Department is incorporating this method into their construction standards. In addition, the following efforts are in progress:

    * Drought tolerant plants are being used on all new medians.

    * Replacement of older median plantings (ivy) with drought tolerant plants. The soil level of the medians has been lowered to prevent runoff and retain water.

    * Drip irrigation is being tried on portions of north Broadway and south Broadway medians. Underground systems have not been perfected to where they are efficient yet, and the industry is continuing to work on the system. An emitter system with spaghetti-sized lines lying on the surface next to each plant is working well. City crews are working to expand the applications of this system.

* Miscellaneous. The following are general efforts to practice conservation wherever practicable:

    * Flow meters are now available which are attached to the main water line and allow one to program a specific amount of water to be applied to an area and then shut the line off. This meter prevents the possibility of a valve's becoming stuck and staying on until someone manually shuts it off.

    * Washing off tennis courts on a monthly basis rather than a weekly basis, despite complaints from users.

    * Investigating the use of drought tolerant hybrid grasses as a development standard.

* Maintaining healthy turf (spraying for weeds, programmed fertilization, etc.) as healthy turf uses less water.

In summary, the Department is constantly experimenting with existing systems and looking for new products and materials to significantly reduce water consumption while providing the community with a functional and aesthetic landscape.

Chamber of Commerce/Economic Development Association. The Chamber of Commerce and the Economic Development Association assisted in the development and distribution of a brochure designed for visitors to Santa Maria entitled "Please Help Us Conserve." It was made available to them at hotels and at the airport, and it included information and tips on how to help conserve water during their stay.

Abbreviations Used in Report

AF - Acre foot or acre feet

AFY and AF/Y - Acre-feet per year

DWR - Department of Water Resources

EIR - Environmental Impact Report

gpcd - Gallons per capita per day

MGD - Million gallons per day

M&I - Municipal and Industrial

mg/L - Milligrams per liter

ppm - parts per million

SWP - State Water Project

SWRCB - State Water Resources Control Board

TDS - Total Dissolved Solids

TH - Total Hardness

Definitions of Terms Used in Report

ACRE-FOOT - The quantity of water required to cover one acre to a depth of one foot; equal to 43,560 cubic feet, or 325,851 gallons.

APPLIED WATER DEMAND - The quantity of water that would be delivered for urban or agricultural applications if no conservation measures were in place.

ARTIFICIAL RECHARGE - The addition of water to a ground water basin by human activity, such as irrigation or induced infiltration from streams, wells, or recharge basins. See also GROUND WATER RECHARGE, RECHARGE BASINS.

BRACKISH WATER - Water containing dissolved minerals in amounts that exceed normally acceptable standards for municipal, domestic, and irrigation uses. Considerably less saline than sea water.

CONJUNCTIVE USE - The operation of a ground water basin in coordination with a surface water storage and conveyance system. The purpose is to recharge the basin during years of above-average water supply to provide storage that can be withdrawn during drier years when surface water supplies are below normal.

CONSERVATION - As used in this report, urban water conservation includes reductions realized from voluntary, more efficient water use practices promoted through public education and from state-mandated requirements to install water-conserving fixtures in newly constructed and renovated buildings. Agricultural water conservation, as used in this report, means reducing the amount of water applied in irrigation through measures that increase irrigation efficiency.

DEPRESSION - Localized reduction of groundwater levels due to pumpage in excess of return flows.

DESALINATION - A process that converts sea water or brackish water to fresh water or an otherwise more usable condition through removal of dissolved solids.

GROSS PUMPAGE - Amount of water actually pumped, regardless of any return flows.

GROUND WATER - Water that occurs beneath the land surface and completely fills all pore spaces of the alluvium or rock formation in which it is located.

GROUND WATER BASIN - A ground water reservoir, together with all the overlying land surface and underlying aquifers that contribute water to the reservoir.

MILLIGRAMS PER LITER - The weight in milligrams of any substance dissolved in one liter of liquid. Nearly the same as parts per million, and many times use interchangeably. Abbreviation: mg/L.

MINING - The withdrawal of water from an aquifer greatly in excess of replenishment; if continued, the underground supply will eventually be exhausted or the water table will drop below economically feasible pumping lifts.

OVERDRAFT - The condition of a ground water basin in which the amount of water withdrawn by pumping exceeds the amount of water that replenishes the basin over a period of years.

PERCHED WATER TABLE - Water trapped above impermeable layers of soil.

PERCOLATION - The downward movement of water through the soil or alluvium to the ground water table.

RECHARGE - Increases in ground water by natural conditions or by human activity. See also ARTIFICIAL RECHARGE.

RECHARGE BASIN - A surface facility, often a large pond, used to increase the infiltration of water into a ground water basin.

RECLAIMED WATER - Urban wastewater that becomes suitable for a specific beneficial use as a result of treatment.

RETURN FLOW - The portion of withdrawn water that is not consumed by evapotranspiration and returns instead to its source or to another body of water.

REUSE - The additional use of once-used water.

SAFE YIELD (GROUND WATER) - The maximum quantity of water that can be withdrawn from a ground water basin over a long period of time without developing a condition of overdraft. Sometimes referred to as sustained yield or perennial yield.

SALINITY - Generally, the concentration of mineral salts dissolved in water. Salinity may be measured by weight (total dissolved solids), electrical conductivity, or osmotic pressure. Where sea water is known to be the major source of salt, salinity is often used to refer to the concentration of chlorides in the water. See also TOTAL DISSOLVED SOLIDS.

SEA WATER INTRUSION - The movement of salt water into a body of fresh water. It can occur in either surface water or ground water bodies.

STORAGE CAPACITY - The space contained in a given volume of deposits. Under optimum use conditions, the usable ground water storage capacity is the volume of water that can, within specified economic limitations, be alternately extracted and replaced in the reservoir.

SUBSIDENCE - A sinking of a large part of the earth's surface or movement in which there is no free side and surface material is displaced vertically downward with little or no horizontal component.

TOTAL DISSOLVED SOLIDS - A quantitative measure of the residual minerals dissolved in water that remain after evaporation of a solution. Usually expressed in milligrams per liter which is the same as parts per million. Abbreviation: TDS. See also SALINITY.

WATER RECLAMATION - The treatment of water of impaired quality, including brackish water and sea water, to produce a water suitable for the intended use.

WATER RIGHT - A legally protected right to take possession of water in a water supply and to divert that water for beneficial use.

WATER TABLE - The upper surface of the zone of saturation (all pores of sub soil filled with water), except where the surface is formed by an impermeable body.

SEA-WATER INTRUSION MONITORING WELLS

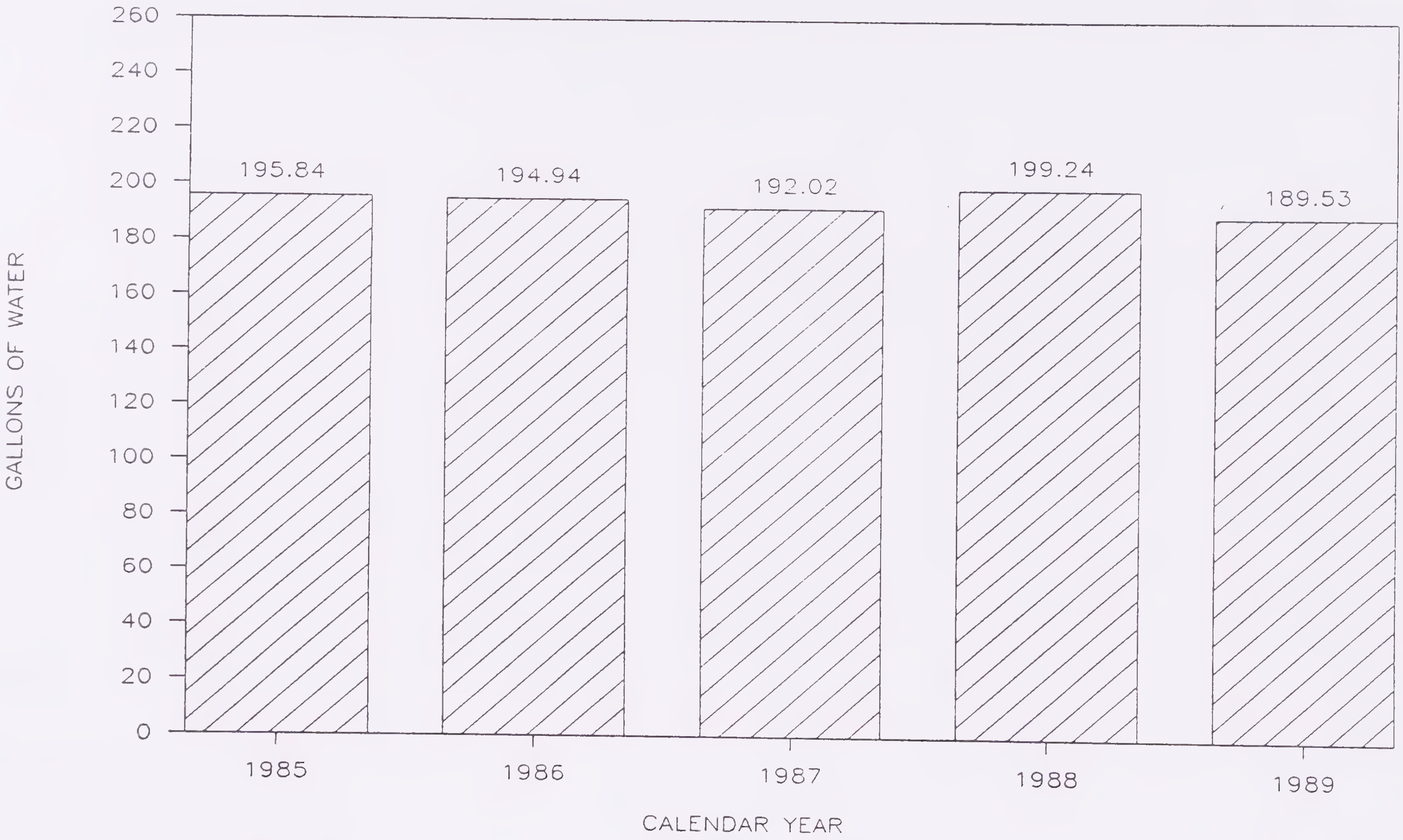
Wells are monitored on a yearly basis by the United States Geological Survey, Water Resources Division, California District which is responsible for gathering the data and publishing the water quality data. The Santa Barbara County Water Agency receives copies of the reports and tracks this data along with other well-monitoring duties countywide. The contact person for information on the sea-water intrusion monitoring program is Chuck Lamb at U.S.G.S. in Sacramento. The phone number and address are as follows: (916) 978-5445 Room W-2239
Federal Building,
2800 Cottage Way
Sacramento, CA. 95825

Two monitoring wells are located west of the city of Guadalupe, Ca. and are on-shore. Each well is fitted with four piezometers at varying depths to monitor the different aquifers. The well descriptions are as follows:

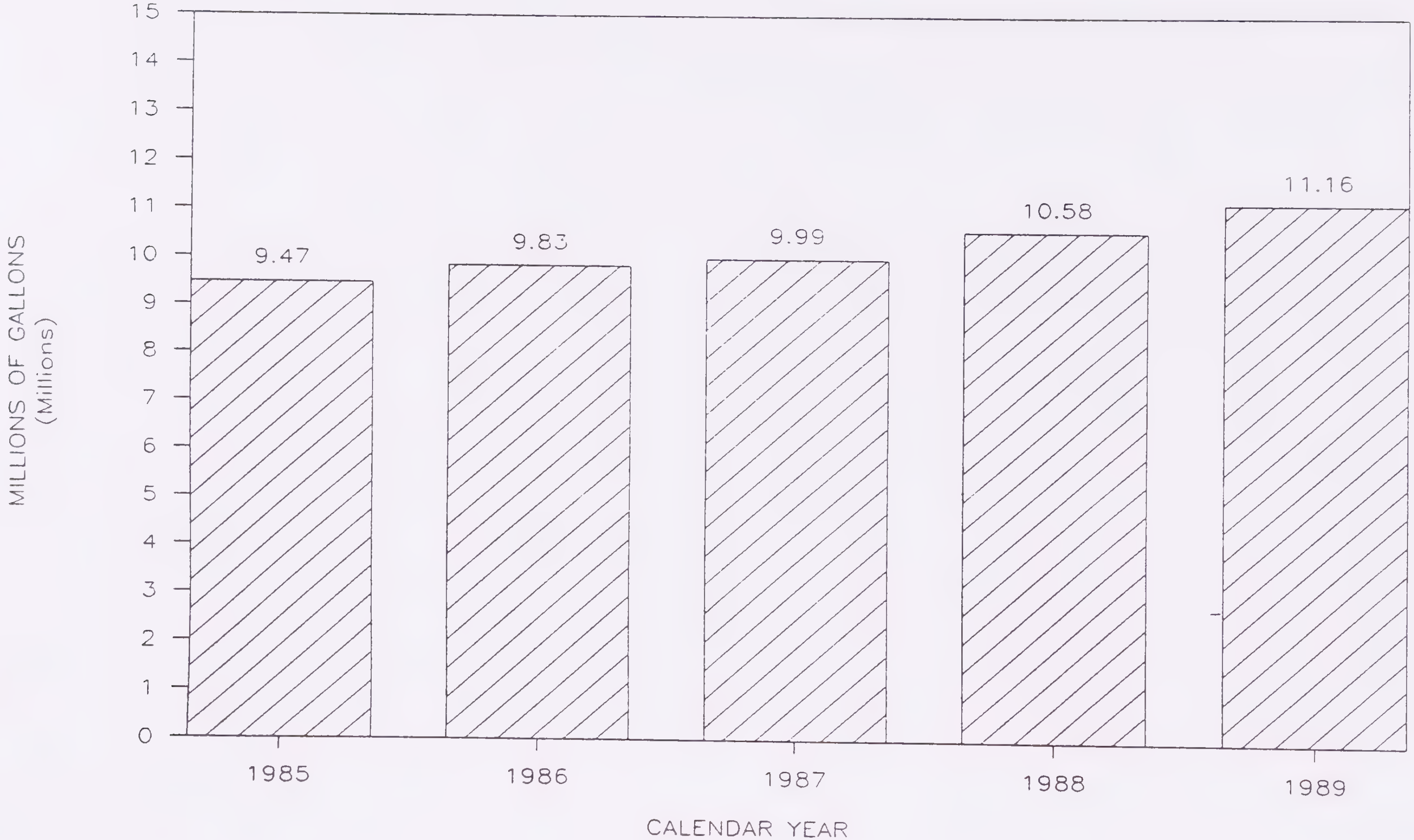
1) 010N036W02Q01S
   02Q03S
   02Q04S
   02Q07S

2) 011N036W35J02S
   35J03S
   35J04S
   35J05S

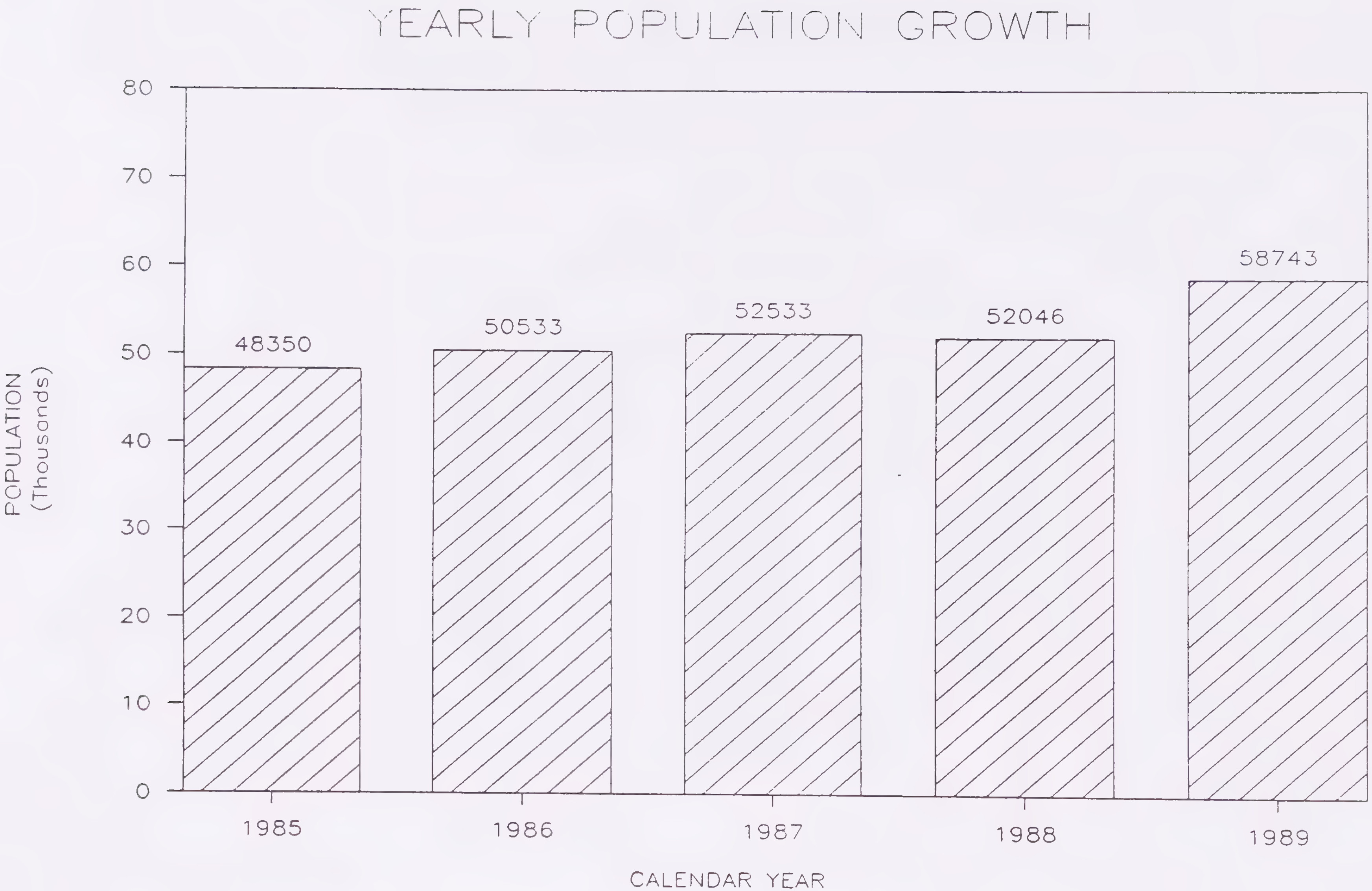
WATER CONSUMPTION — PER CAPITA, PER DAY



AVERAGE DAILY CONSUMPTION



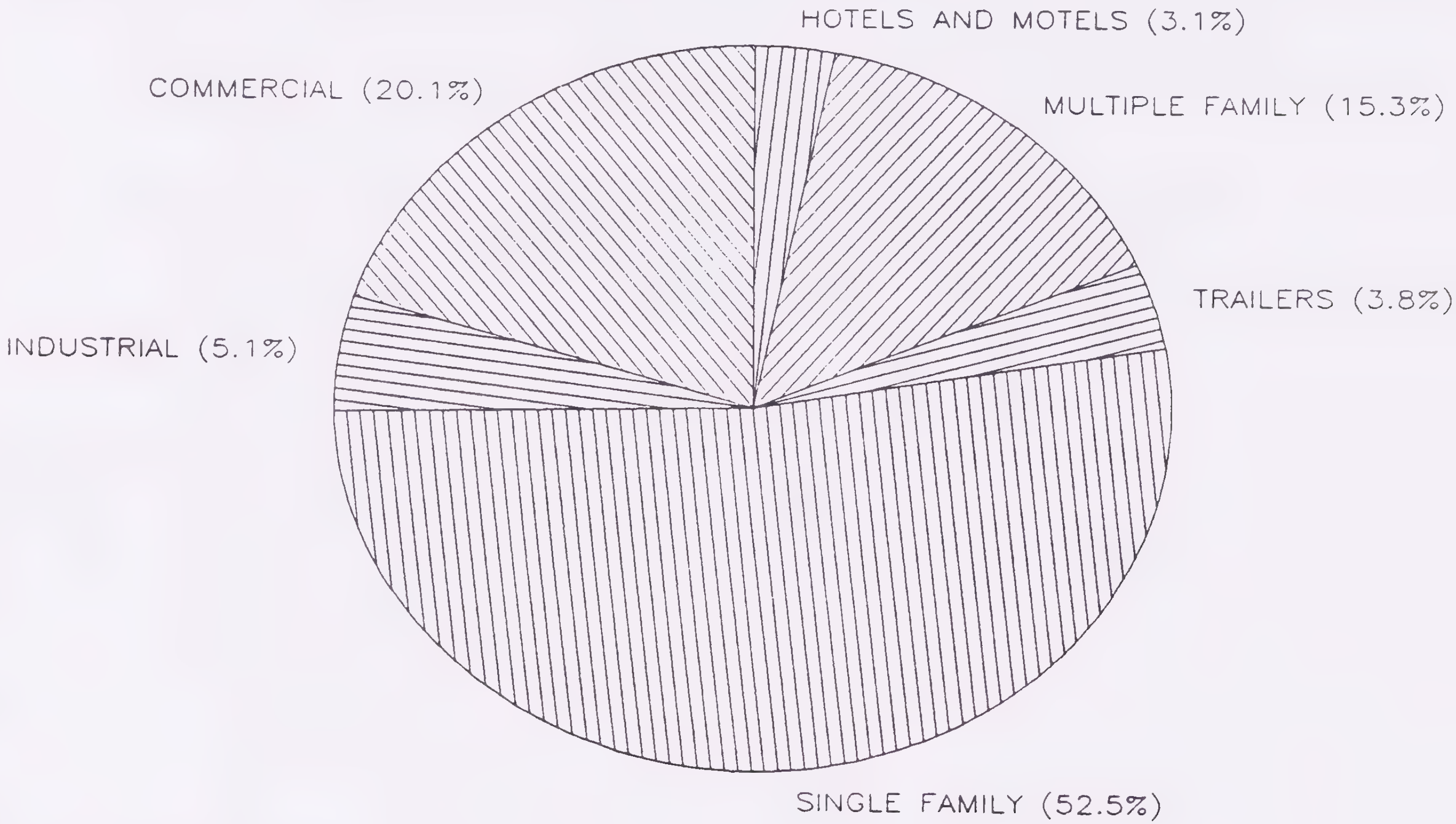
WATER ACCOUNTS


YEARLY POPULATION GROWTH
POPULATION
(Thousands)
80
70
60
50
40
30
20
10
0
48350
50533
52533
52046
58743
1985
1986
1987
1988
1989
CALENDAR YEAR

APPENDIX B

CURRENT PROPORTIONATE WATER USE

FOR THE CITY OF SANTA MARIA

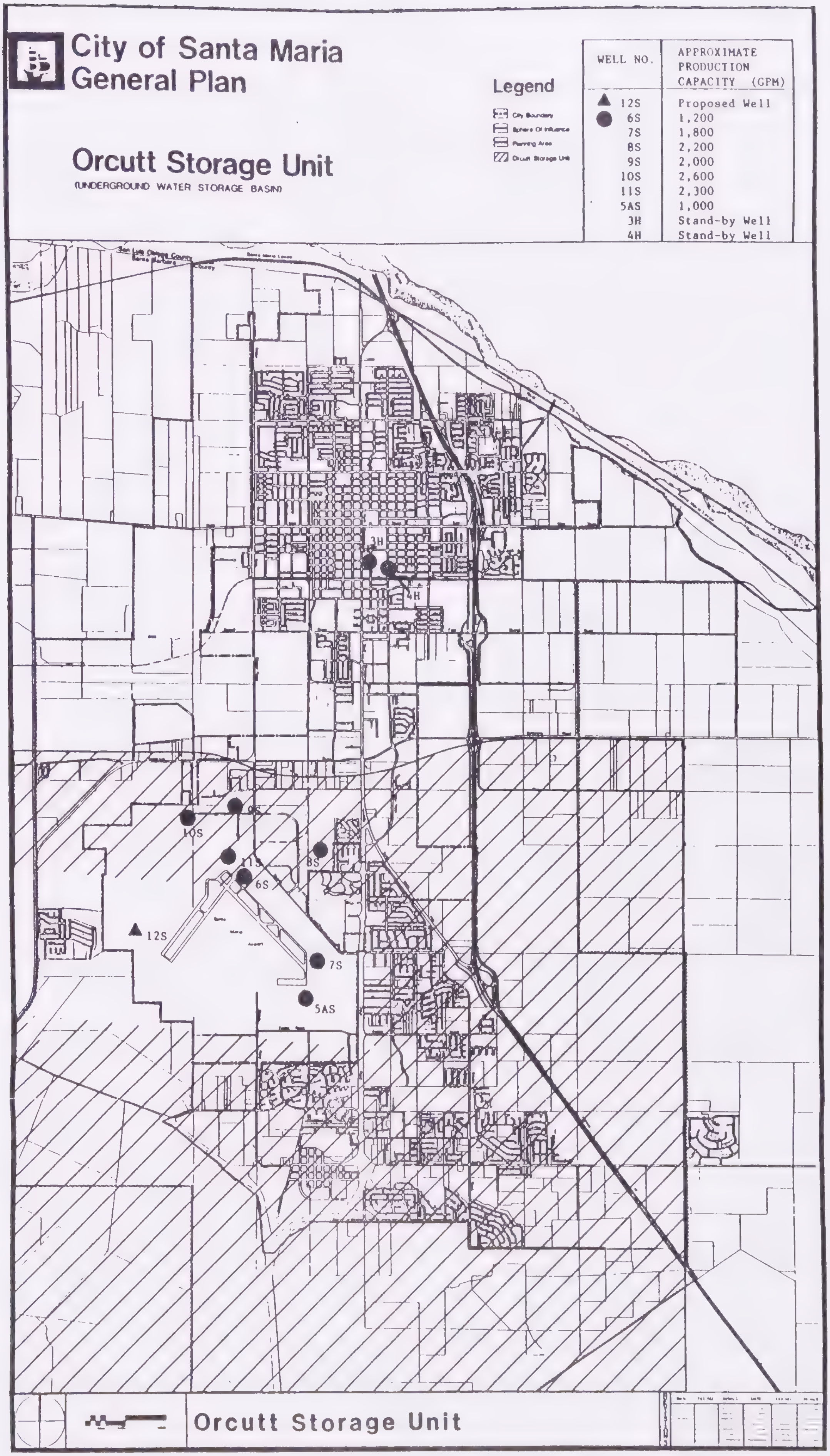


APPENDIX B

CITY OF SANTA MARIA
POPULATION/WATER CONSUMPTION

YEAR	POPULATION	ACRE FEET (CAL. YEAR)	ACRE FEET PER CAPITA	AVG. GAL. PER CAPITA PER DAY
1967	31,932	5,954	0.1865	166.48
1968*	32,175	6,581	0.2045	182.13
1969	32,600	6,540	0.2006	179.12
1970	32,749	7,391	0.2257	201.51
1971	33,550	7,140	0.2128	190.02
1972*	34,000	7,422	0.2183	194.38
1973	33,500	6,925	0.2067	184.57
1974	33,250	7,185	0.2161	192.94
1975	33,645	7,382	0.2194	195.90
1976*	33,850	8,033	0.2373	211.31
1977	34,850	7,510	0.2155	192.41
1978	35,539	7,446	0.2095	187.07
1979	37,150	8,142	0.2192	195.69
1980*	39,685	8,754	0.2206	196.42
1981	40,297	8,975	0.2227	198.86
1982	41,721	8,314	0.1993	177.93
1983	44,308	8,888	0.2006	179.11
1984*	46,680	10,545	0.2259	201.15
1985	48,350	10,605	0.2193	195.84
1986	50,533	11,033	0.2183	194.94
1987	52,046	11,193	0.2151	192.02
1988*	52,955	11,849	0.2238	199.24
1989	53,713	12,471	0.2322	207.28
1990	61,284	12,059	0.1968	175.67
	10 YEAR AVERAGE		0.2154	192.20

* LEAP YEAR


City of Santa Maria
General Plan
Orcutt Storage Unit
(UNDERGROUND WATER STORAGE BASIN)
Legend
City Boundary
Sphere Of Influence
Planning Area
Orcutt Storage Unit
WELL NO.
APPROXIMATE PRODUCTION CAPACITY (GPM)
12S Proposed Well
6S 1,200
7S 1,800
8S 2,200
9S 2,000
10S 2,600
11S 2,300
5AS 1,000
3H Stand-by Well
4H Stand-by Well
3H
4H
9S
10S
11S
8S
6S
12S
7S
5AS
Orcutt Storage Unit

BIBLIOGRAPHY/REFERENCES

Alameda County Water District. Urban Water Management Plan, November 1985.

Carollo, John, Engineers. City of Santa Maria Urban Water Management Plan. December 1987.

California Department of Water Resources. Sea-Water Intrusion in California. Bulletin No. 63-5. October 1975.

California Department of Water Resources. Groundwater in the Arroyo Grande Area. June 1979.

California Department of Water Resources, Southern District. Water

Action Plan for the San Luis Obispo - Santa Barbara Counties Area. May 1981.

California Department of Water Resources. Recommended Water Management Plan for Santa Barbara County Flood Control and Water Conservation District. December 1983.

California Department of Water Resources, Southern District, in conjunction with Santa Barbara County Flood Control and Water Conservation District. Santa Barbara County State Water Project Alternatives. April 1985.

California Department of Water Resources. Enlargement of Cachuma Reservoir and Safety Modifications of Bradbury Dam - Santa Barbara County, California. January 1987.

California Department of Water Resources. Draft Environmental Impact Report - State Water Project, Coastal Branch, Phase II and Mission Hills Extension. June 1990.

Henningson, Durham, and Richardson. Ecosciences Division. Final Environmental Impact Report on Santa Clara County Weather Modification Program. December 1975.

Huges, Jerry L., Evaluation of Groundwater Quality in the Santa Maria Valley, California, U. S. Geological Survey, Water Resources Investigation 76-128, July 1977.

Jones and Stokes Associates, Inc. Final Environmental and Water Resources Reconnaissance Study for State Water Project and Alternatives. January 1979.

Lawrance, Fisk, and McFarland, Inc. Final Report Nipomo Mesa Planning Study; Water, Wastewater, and Drainage Studies. August 24, 1987.

Santa Barbara County Grand Jury. Final Report, 1987-1988. June 30, 1988.

Santa Barbara County Resource Management Department. First Revised Public Draft. Santa Barbara County Comprehensive Plan; Conservation Element; Groundwater Resources Section. May 1989

Santa Barbara County Water Agency, "Adequacy of the Santa Maria Groundwater Basin." November 1977.

Santa Barbara County Water Agency, "Adequacy of the Groundwater Basins of Santa Barbara County." December 1977.

Santa Maria, City of. Environmental Resources Management Element, General Plan. 1981.

Santa Maria, City of. Annual Pretreatment Program Report. 1989.

Santa Maria, City of. Wastewater Treatment Plant and Laboratory Report. 1989.

State Water Resources Control Board; Regional Water Quality Control Board, Central Coast Region. Water Quality Objectives for Santa Maria Groundwater Basin. Staff Report (revised). May 1985.

Toups Corporation. Santa Maria Valley Water Resources Study. 1976.

Toups Corporation, Environmental Studies Group. Environmental Impact Report for East Orcutt Joint Project. 1978.

U.S. Geological Survey. Hughes, J. L., and Freckleton, J. R. Groundwater Data for the Santa Maria Valley, California. Open-File Report. May 1976.

U.S. Geological Survey. Hughes, J. L. Evaluation of Ground-Water Quality in the Santa Maria Valley, California. Water Resources Investigation 76-128. July 1977.

U.S. Geological Survey. Lipinski, Paul. Comparison of Two Methods for Estimating Ground-Water Recharge in 1978-80, Santa Maria Valley, California. Water Resources Investigations Report 85-4129. May 1985.